SCIENCE

VOL. 89 FRIDAY, JUNE 9, 1939 No. 2319

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. MCKEEN CATTELL and published every Friday by

THE SCIENCE PRESS

New York City: Grand Central Terminal
Lancaster, Pa. Garrison, N. Y.

Annual Subscription, $6.00 Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary in the Smithsonian Institution Building, Washington, D. C.

AN EVALUATION OF THE FACTORS RESPONSIBLE FOR PUBLIC HEALTH PROGRESS IN THE UNITED STATES[1]

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ONE of the striking phenomena of the twentieth century and to some extent also of the last quarter of the nineteenth century has been the curtailment of premature mortality, the prevention of disease and the prolongation of the average life span of man. Since 1880, the general death rate has been diminished more than 50 per cent. and the average expectancy of life at birth has been increased from 40 years to approximately 61 years. Typhoid fever and diarrhea and enteritis have diminished almost to the vanishing point in many communities; cholera and typhus fever are rarely causes of death in this country to-day; the incidence and deaths from diphtheria have been greatly reduced; smallpox is under control in all communities where vaccination is practised; bubonic plague, though endemic in certain restricted areas, is not responsible for many cases of disease or many deaths; the infant death rate has been diminished more than 75 per cent.; the death rate from tuberculosis, at one time the most important single cause of death, has been reduced 75 to 80 per cent.; hookworm is controlled in the South; yellow fever is now non-existent in this country; and malaria is under better control. This remarkable progress in public health occurred during a period of rapid and increasing urbanization and congestion in this country, when conditions should have favored high death rates. Obviously, some factor or factors must

[1] Contribution No. 146 from the Department of Biology and Public Health, Massachusetts Institute of Technology, Cambridge, Mass.

have been at work to effect this tremendous saving of human life, and a correct evaluation of these factors should therefore be of great interest and value. Shryock[2] describes the conditions that prevailed prior to the advent of modern public health measures as follows:

> The tragic history of the major endemic diseases, typhus, typhoid and tuberculosis, is familiar enough. So far as can be judged from the imperfect bills of mortality, urban death rates rose ominously during the first half of the nineteenth century. New York City, which was most inundated by poor immigrants and which grew most rapidly, affords a striking example. In 1810, the crude death rate had been reported as about 21 per 1,000; by 1857, it had risen to around 37 per 1,000—an increase of almost 80 per cent. within 50 years. Rates were lower in Philadelphia, but higher in New Orleans. What an increasing mortality implied in morbidity rates, to say nothing of "subclinical illness," is obvious enough.

And in 1937, the estimated general death rate for the United States, based on 85 per cent. of the total population, was 10.9 per 1,000 population.[3]

The remarkable saving in human life can not be appreciated fully from a mere citation of reductions in death rates and the increase in the average expectancy of life at birth. It is necessary to know the difference between the actual number of deaths occurring to-day and the number of deaths that would have occurred if the old death rates still prevailed. This information is presented in Table 1 for the years 1900 and 1935, both for all causes of death as well as certain principal causes.[4]

It is evident from Table 1 that approximately 768,000 lives are saved annually among the white population of the United States as a result of the curtailment in the death rate since only 1900, an extraordinary achievement based on magnitude alone but one that can hardly be evaluated in terms of the prevention of human misery and suffering and in terms of the maintenance of the unity of families. Among the outstanding achievements noted in the preceding table are the reduction in the deaths from tuberculosis, influenza and pneumonia, diarrhea and enteritis, diphtheria and typhoid and paratyphoid fevers. The saving of life from these diseases alone is equivalent to 61 per cent. of all the lives saved by the reduction in mortality since 1900.

Contrariwise, there has been no reduction in the mortality from such diseases as organic heart disease, cancer and diabetes or from external causes. Their significance has rather increased as the population has grown older and as the more readily preventable deaths have been brought under control. The ten principal causes of death in the United States to-day,[5] presented in the order of their importance, are heart disease, cancer, pneumonia, nephritis, accidental violence, cerebral hemorrhage, tuberculosis, congenital malformations and diseases of early infancy, diabetes and in-

TABLE 1

ACTUAL DEATHS IN THE WHITE POPULATION OF THE UNITED STATES DURING 1935 FROM ALL CAUSES OF DEATH AND FROM SEVERAL PROMINENT CAUSES OF DEATH, COMPARED WITH THE CORRESPONDING NUMBERS EXPECTED IN THAT YEAR ON THE BASIS OF THE MORTALITY RATES BY SEX AND AGE PREVAILING IN 1900*

Cause of death	Deaths in 1935		Lives saved in 1935 by improvement in mortality since 1900	Lives lost in 1935 by retrogression in mortality since 1900
	Actual	Expected on basis of mortality in 1900		
All causes	1,207,359	1,975,761	768,402	
Tuberculosis, all forms	51,269	224,384	173,115	
Influenza and pneumonia†	110,191	232,187	121,996	
Diarrhea and enteritis‡	17,018	125,448	108,430	
Principal communicable diseases of childhood	13,182	72,127	58,945	
Measles	3,435	12,590	9,155	
Scarlet fever	2,646	9,336	6,690	
Whooping cough	3,673	10,715	7,042	
Diphtheria	3,428	39,486	36,058	
Typhoid and paratyphoid fever	2,386	35,652	33,266	
Nephritis	89,240	115,239	25,999	
Cerebral hemorrhage and softening	85,732	102,535	16,803	
Puerperal state	10,018	14,504	4,486	
Organic heart disease	212,167	153,584		58,583
Cancer	129,124	86,103		43,021
Diabetes	26,606	14,301		12,305
External causes (excluding suicides)	94,851	84,688		10,163
All other causes	365,575	715,009	349,434	

* As observed in the original death registration states and the District of Columbia, 1900.
† Excluding capillary bronchitis.
‡ Includes duodenal ulcer.

[2] Richard H. Shryock, *Am. Jour. Public Health*, 27: 10, 965–971, October, 1937.

[3] *Public Health Reports*, 53: 18, 701–719, May 6, 1938.

[4] Metropolitan Life Insurance Company, *Statistical Bulletin*, 18: 11, 3, November, 1937.

[5] Metropolitan Life Insurance Company, *Statistical Bulletin*, 19: 8, 7, August, 1938.

fluenza. The relative significance of these causes of death varies with the section of the country under consideration, but, for the country as a whole, they represent the ten leading causes of death. Heart disease is responsible for nearly 25 per cent. of all the deaths in the United States, and its annual toll is more than twice the number of deaths resulting from cancer. Many of the "Big Ten" represent the degenerative diseases. How much can be done to prevent mortality resulting from senility and from the wear and tear of daily living by recognized public health and medical procedures is decidedly problematical.

Reference has been made already to the extension of the average expectancy of life at birth since 1880. This progress was not limited to the last two decades of the nineteenth century, but has continued into the twentieth century as well. The actual progress along this line since the beginning of the present century is indicated in Table 2.[5]

TABLE 2

EXPECTATION OF LIFE AT BIRTH AMONG TOTAL PERSONS (WHITE AND COLORED) AND AMONG WHITE PERSONS BY SEX FOR THE UNITED STATES FROM 1901 TO 1936

Year	Expectation of life at birth in years		
	Total persons	White males	White females
1936*	60.81	60.18	64.36
1935*	61.37	60.72	64.72
1934*	60.79	60.24	64.18
1933*	61.26	60.86	64.40
1932†	61.07	60.69	64.38
1931†	60.26	59.88	63.56
1929–1931	59.57§	59.31‖	62.83‖
1919–1920¶	....	55.33	57.52
1910‡	51.49	50.23	53.62
1901‡	49.24	48.23	51.08

* Total United States.
† United States, excluding Texas.
‡ Original death registration states.
§ This figure relates to 1930 only for the United States, excluding Texas.
¶ Aggregate of 27 states; not computed for total persons.
‖ United States, excluding Texas and South Dakota.

During the first three decades of the twentieth century, the average expectancy of life at birth was increased by almost exactly eleven years—in spite of a devastating influenza-pneumonia epidemic and our participation in the World War with its attendant loss of life. Since 1930 there has not been any significant variation in average longevity. Perhaps the limit is being reached in our ability to prevent death with our present knowledge. It may be necessary for us to await the further contributions of the biologist, chemist and physicist in order to achieve additional success in deferring death. It is of interest to note, however, that at age 34 the average citizen has just as many years ahead of him as behind him; that at age 46, the average citizen may still look forward to a quarter century of life; and that even for those fortunate individuals who have attained the proverbial threescore years and ten, there still remain, on the average, 9.25 years of life.

According to Britten,[6] the causes of death listed in Table 3 were responsible for 81 per cent. of the total mortality in the United States in 1933.

TABLE 3

DEATH RATES PER 100,000 OF THE POPULATION IN THE U. S. IN 1933 BY SPECIFIC CAUSE, ARRANGED IN ORDER OF NUMERICAL IMPORTANCE

Cause of death	Death rate per 100,000 population
Diseases of the heart	228.0
Cancer and other malignant tumors	102.2
Influenza and pneumonia	95.6
Nephritis and other kidney diseases	85.7
Cerebral hemorrhage	84.0
Tuberculosis, all forms	59.5
Diseases of early infancy and congenital malformations	50.6
Automobile accidents	24.7
Diabetes mellitus	21.3
Diarrhea and enteritis	17.2
Arteriosclerosis	16.8
Suicide	15.9
Appendicitis	14.1
Puerperal state	10.3
Hernia and intestinal obstruction	10.0
Homicide	9.6
Gastritis	9.1
Syphilis	8.8
Cirrhosis of liver	8.7
Gall bladder diseases	6.9
Prostate diseases	6.0
Tumors, benign	4.6
Diphtheria	3.9
Tonsilitis	3.8
Malaria	3.7

The data presented in the preceding table indicate the principal causes of death in the United States and their relative importance. They are not always synonymous with the conditions or diseases that incapacitate an individual. They demonstrate once more that many of the conditions that result in death are due to the aging of the body or to non-preventable organic defects.

"Modern longevity is the product of modern enlightenment. Man himself, as a physical and physiological unit, has probably changed but little since remote antiquity. But man's power over his environment has changed immensely."[7] It would seem that man's increasingly effective mastery over a defective environment and his genius in developing biological and chemical agents for the prevention and treatment of certain diseases have been largely responsible for the progress that has been made. The demonstration of Pasteur that germs were responsible for fermentations and by Koch that germs were responsible for animal and human diseases made it possible to establish a new theory of the sources and modes of infection which in turn led to the virtual control of such diseases as typhoid fever, cholera, dysentery, paratyphoid fever and other ailments in this and other countries where public health progress has been marked. The demonstration by Theobald Smith that insects can be vectors

[6] Rollo H. Britten, *Public Health Reports*, 51: 29, 947–969, July 17, 1936.

[7] Louis I. Dublin and Alfred J. Lotka, "Length of Life," p. 154. The Ronald Press Co., New York, 1936.

of disease led eventually to the conclusive evidence by Ronald Ross that the anopheles mosquito was involved in the life cycle of the malarial parasite and its transmission to man. This work undoubtedly influenced the American Yellow Fever Commission in Cuba at the beginning of the twentieth century in their study of yellow fever which led ultimately to the demonstration that yellow fever is also a mosquito-borne disease. Thus two of the great scourges of man were attacked with newer knowledge and were brought under more effective control. The same held true for other insect-borne diseases, such as typhus fever and bubonic plague, as well as those diseases that are transmitted by flies. The effective control of the environment has brought under control in this country the intestinal and insect-borne diseases.

The establishment of the germ theory of disease was also responsible for the application of disinfectants and germicides to surgical wounds and to pyogenic infections of every variety, and led first to antiseptic surgery and later to aseptic surgery. It also stimulated research into the development of newer and better germicides. In this work many bacteriologists and chemists have cooperated. To these scientific workers the world is indebted for the introduction of new and better weapons in the conquest of disease, and for making it possible for surgeons to explore the human body with relative impunity and to perform radical operations to save human life which would have been impossible but a scant 50 or 60 years ago. The development of sulphanilamide in recent years is a good illustration of a life-saving contribution by a scientific worker. Likewise the discovery of x-rays and radium rays by physicists and chemists has had far-reaching effects both in the diagnosis and treatment of human disease. Many lives have been saved by the judicious use of germicidal agents; pyogenic infections have been prevented or controlled and surgery has been rendered safe beyond all human expectations. This success in preventing disease, controlling death and prolonging life is due to a more effective control of the environment.

Another aspect of environmental control which has had a profound effect on human health and vitality has been a combination of cleanliness, refrigeration and heat treatment in the production and safeguarding of many foods. In no instance is this success so obvious as in the protection of city milk supplies in the United States. An important but perishable food, often laden with dung and disease, has been sanitated, refrigerated and rendered safe through pasteurization. As a result, milk-borne diseases, including typhoid fever, diphtheria, scarlet fever, septic sore throat, undulant fever and tuberculosis of bovine origin, have been brought under control, and rarely occur in our large cities, where all or nearly all the milk supply is pasteurized. In all probability, there is not another country in the world where the milk supply is as clean and as safe as it is in the United States. The significance of this condition in infant and child health and in the nutrition and health of the entire population can hardly be over-estimated.

What has been accomplished in sanitating and safeguarding our public milk supplies has been matched with equal effectiveness in the purification and protection of our public water supplies and in the protection and safety of other aspects of our food supply. Most of this has been achieved through engineering effort—man's effective control over his environment to protect his health and to promote his comfort and convenience. When one realizes that billions of gallons of water are used and consumed in the United States every day; that this vast amount of water is purified or safeguarded and then rendered safe usually by chlorination; that one may travel the length and breadth of a great and populous continent and feel reasonably certain that the water can be consumed in the raw state with impunity; that this magical accomplishment so essential to health and life must be repeated without interruption day after day; only then can one begin to appreciate the debt which society owes to the activity of the public health engineer. Any serious interruption in the continued flow of water to our large cities or any serious infection of the public water supply which was not eliminated or controlled would make a mockery of our urban civilization and would create an epidemic situation that would make the pandemic of influenza-pneumonia of 1918 seem like a mild outbreak of disease.

Through other engineering developments in the fields of refrigeration, cold storage and rapid means of transportation, coupled with sanitary and veterinary inspections, our solid food supply has been safeguarded and delivered to every community in a fresh condition. Food is the source of all human energy and for that reason is basic in the maintenance of life and in building up the vital resistance of the body against disease. A clean, fresh and wholesome food supply is a basic public health requirement. Happily through the use of cookery—another step in man's control over his environment—our clean, fresh and wholesome food supplies have also been rendered absolutely safe.

The construction of a new road or a new link to a main railroad may mean more in promoting the health of a community than any other thing the community may do. Rapid means of transportation are essential for bringing food into the community in sufficient variety and freshness. Rapid means of transportation are also necessary to bring tools and other equipment

into a community in order to aid the people in their efforts to master their environment; and control over one's environment is essential for promoting and maintaining good heatlh.

The construction of sewers and the building of sewage treatment plants have done much to remove a nuisance and menace to health in the vicinity of the home. Because sewage treatment hasn't kept pace with sewer construction, the improper disposal of sewage has created newer public health problems which demand solution. Public water supplies, shellfish growing areas, bathing places and recreational and camp sites must be protected against sewage pollution. The country is slowly but surely making progress in the elimination of some of the worst cases of pollution. Chicago altered the natural course of a river in order to avoid polluting its drinking water with its own sewage. Since then it has built sewage treatment works to cope with the problem of pollution more effectively. New York, New Haven, Providence, Baltimore, Milwaukee, Indianapolis and many other cities have built sewage treatment plants and are operating them continuously. It is expected that badly polluted streams will be improved; that fish life will return; that land values will improve and that the other undesirable features of uncontrolled sewage pollution will be prevented or greatly ameliorated.

The introduction of the water closet into the home and the provision of adequate plumbing facilities with hot and cold running water has doubtless had a very significant effect on the health, comfort and convenience of a great portion of the population. However, it is impossible to evaluate its significance in terms of preventable diseases and deaths. It has eliminated the privy from the vicinity of the home with its attendant nuisances and health hazards. It has helped to suppress flies. It has favored intestinal hygiene throughout the year. It has made for human comfort, convenience and decency. It has promoted hand hygiene, mouth hygiene and body cleanliness. It has stimulated sanitation in the home and the cleanliness of foods and eating utensils. It represents another environmental factor which has definite public health significance.

In rural areas and in unsewered sections of cities, the construction of fly-tight privies has controlled soil pollution and the breeding of flies and has served as a factor in the control of intestinal diseases, including hookworm. This public health engineering activity also represents an advance in man's effective control of his environment.

Other items in man's control of his environment which have promoted the public health in the broadest sense include the control of insects and rodents, the sanitation of food stores and restaurants, the sanitation of public buildings and public conveyances, the removal and proper disposal of all forms of municipal refuse, the sanitation of shellfish and shellfish growing areas, of swimming pools and bathing places, of summer camps and tourist camps, boarding houses, hotels and other similar places. In addition, campaigns against noise, smoke, odors and other community nuisances have been waged and effective results obtained in many instances. The problem of heating and ventilation and of air conditioning in general has received a great deal of consideration. This is true both for domestic residences as well as for business and industrial establishments. As a result, air-conditioning in the home is becoming more adequate and satisfactory; while in industry excessive dusts, heat and humidity and obnoxious or injurious fumes, vapors and gases are being removed. The relationship of sunlight to physical and mental health has also received some consideration, as well as the removal of the agents of disease from the atmosphere of large assembly halls. These factors affect the vital resistance of the individual and hence the public health.

Reference has been made to the improvement of man's industrial environment and its effect on his health and comfort. Included in the same category are the prevention of industrial accidents of all types, improvement in illumination, avoidance of excess fatigue and over-exposure, the provision of rest periods, the curtailment of the work-day, the provision of vacations with pay and the whole gamut of changes in the industrial structure which consider the health and well-being of the worker to an ever-increasing degree. Recently, there has been a rapid acceleration of interest on the part of public health workers in the field of industrial hygiene and sanitation. In many instances state divisions of industrial hygiene have been formed under the auspices of the health department. Most of the larger industries have had such divisions of their own for many years, and these invariably have produced very satisfactory results. In nearly every state, special statutes exist which regulate the conditions of employment and which aim to protect and promote the health and welfare of the worker.

Industrial hygiene and sanitation have two aspects, medical and engineering. The engineering aspect includes the chemical where such problems exist. It is obvious that from the standpoint of environmental control in industry—that control which affects the health and welfare of *all* the workers in a factory or a part of it—the engineering aspect is of predominant importance. It is another sphere of public health activity in which the public health engineer has played and is continuing to play in a greater measure a rôle of real importance.

Still another aspect of environmental control which is receiving increasing attention is the matter of providing healthful housing for our population. The problem is an old one, and much improvement has

been accomplished over the past five or six decades. The issue has been elevated to a position of national importance and concern through the appropriation of vast sums of money by the Federal Government for slum clearance, and through the activity of the American Public Health Association Committee on the Hygiene of Housing as well as other groups. Healthful housing conditions favor good health in a variety of ways, and since the home is the environment of the individual for 8 to 24 hours each day, its public health significance is of appreciable importance. It involves such questions as water supply, sewerage, refuse disposal, drainage, insect and rodent control, lot overcrowding, congestion in the home, safety from fire and accidents, air conditioning, access to sunlight, freedom from noise, odor and smoke nuisances, play space for children and various other items of significance to the public health in the broadest sense.[8]

Another environmental factor which has had an unmeasurable but significant effect on the prevention of disease and premature mortality and the promotion of good health has been the improvement in the standard of living. Working hours have been reduced, rest periods in industry have been introduced, the minimum age of employment has been fixed by law in many instances and real wages are more satisfactory than in any other country in the world. Added to this improvement in social conditions has been the great progress in industrial hygiene and sanitation outlined above. More significant still is the revolutionary change in our knowledge of what constitutes an adequate and satisfactory diet and the application of that knowledge to the daily lives of our people. While much progress can still be made in the scientific and adequate feeding of our population, the fact remains that the wide-spread use of vitamins and minerals in the diet, coupled with proteins, carbohydrates and fats, has helped to build up and maintain the resistance of the population against disease. Adequate and satisfactory nutrition is the foundation on which the public health must rest.

This conclusion is supported by the happy but anomalous experience of the depression period, 1930–1936. In spite of wide-spread unemployment and curtailed health department budgets; in spite of diminished public health clinical and nursing activities, the health of the people either did not suffer at all or did not suffer sufficiently to be reflected in the death rates. As a matter of fact, the general death rates for the period under consideration showed a downward trend and the average expectancy of life at birth actually increased somewhat. This is borne out by the statistics cited in Table 4.[9] We have the apparent anomaly, therefore, that the public health in the United States seemed to improve during great economic distress and in spite of curtailed health department budgets.

TABLE 4

GENERAL DEATH RATE, UNITED STATES REGISTRATION AREA, 1921–1936

Year	Death rate per 1,000 population
1921	11.6
1922	11.7
1923	12.2
1924	11.7
1925	11.8
1926	12.3
1927	11.4
1928	12.1
1929	11.9
1930	11.3
1931	11.1
1932	10.9
1933	10.7
1934	11.0
1935	10.9
1936	11.5
1937	10.9*

* Based on data for 40 states representing 85 per cent. of the total United States population. Cited in *Public Health Reports*, 53: 18, 708, May 6, 1938.

What are the reasons for this anomaly? Perhaps they will never be known. Certainly no public health worker would advocate the curtailment of health department appropriations as a means of cutting the death rate and extending the life span. The answer, I believe, is found in the fact that the public health is intimately dependent on the control of the environment and that public health clinical activities are not important to the same degree. During the depression, our public water supplies were still purified, our sewers continued to function, public milk supplies were still safeguarded by pasteurization, food supplies were still safeguarded as to freshness, wholesomeness and absence of infection, and above all nobody was allowed to die of starvation or of cold. As a matter of fact, relief agencies insisted on at least a minimum but entirely complete and well-balanced diet, and the same agencies provided fuel for protection against the cold. As a result, the vital resistance of the people was maintained and excess disease and deaths did not occur. There were also certain definite public health advantages that can be credited to the depression. Exposure to industrial hazards and accidents was greatly diminished, smoke pollution of the atmosphere was greatly abated and people had more time for rest and relaxation. As a result, even the death rate from tuberculosis[10] continued downward rather than upward, as might have been expected, for in 1933 the rate in 41 states was 55.5 per 100,000 population; in 1934, it was 52.9; in 1935, 51.6; in 1936, 51.7 and in 1937, 49.6.

Another environmental factor which has had a real but unmeasurable effect on health and vitality has been

[8] M. P. Horwood, "Housing and Health." *The Commonhealth* (Mass. Dept. of Public Health), 25: 95–102, June, 1938.

[9] *Public Health Reports*, 53: 5, 168–171, February 4, 1938.

[10] *Public Health Reports*. 53: 701–719, May 6, 1938.

the conscious provision of playgrounds, parks and recreational facilities for the people. Coupled with this has been the growing practice of providing vacations with pay for the industrially employed. In France and Germany this practice has been fostered by the state. In the United States, it is largely the responsibility of private business and industry. Whatever the auspices, the body has an opportunity for periodic rest and relaxation without financial anxiety, and this, coupled with life in the open to a greater or lesser extent, has a beneficient effect on the public health.

Finally, the significance of the environment in the public health picture can be appreciated also by imagining what would happen in a short time to our much-vaunted civilized security if we ceased to protect our water supplies or interrupted their distribution; if the sewerage systems of our cities ceased to function; if garbage and other refuse materials ceased to be removed from the home by organized methods; if city milk supplies ceased to be pasteurized or heated in the home; if all industrial safeguards were suddenly removed and ceased to function. It is very simple to visualize what would happen, for New York City had two experiences recently that illustrate very graphically that human health and well-being are fundamentally dependent on the continued and effective control of the environment.

The first condition resulted when the flow of electric current below 59th street was interrupted for a brief period—30 minutes or more—shortly after 5 P.M. during the winter season. The subways and elevated lines ceased functioning at the hour of maximum demand; elevators in buildings stopped operating; electric heaters and electric refrigerators ceased to function; likewise electric pumps for water, milk and all possible uses; houses, stores, offices and city streets were thrown into utter darkness and people into utter panic because of fear of theft and the unleashing of man's worst instincts. Here the continuance of public health and public safety was dependent on the prompt resumption of the flow of electricity—a purely environmental factor.

The second illustration refers to the strike among the elevator operators in Manhattan. It is only necessary to mention such a condition to one familiar with the situation in New York to appreciate its public health significance. Elderly people with weak hearts could not do much climbing without running serious risk of irreparable damage. All the food had to be carried upstairs and the seriousness of this problem can be easily recognized. All the garbage had to be carried or thrown downstairs and one can readily imagine that even the fashionable environment of Park Avenue suffered somewhat. We must agree with Wolman[11] that "civilization rests upon a thin crust of environmental protection."

Charles Gilman Hyde[12] has presented a very thorough picture of the indispensability of the public health engineer to-day. Those individuals who say glibly that the public health movement has evolved through three stages—the control of the environment, the period of the bacteriologist and the period of the physiologist—and who say further that the era of environmental sanitation is behind us, know not whereof they speak. The era of environmental sanitation must be with us constantly if we are to maintain the great gains in human health that have been accomplished; and the control of the environment in the broadest possible sense must be extended to new limits if we are to meet the other aspects of healthful living—the promotion of the comforts and convenience of organized society.

This review has shown, I believe, that there exists an intimate relationship between the effective control of the environment and the great progress that has been made during the past 50 or 60 years in preventing disease and premature mortality, in extending the average expectancy of life at birth and in promoting joyous, healthful living. The control of the environment has not been the only factor involved, as will be demonstrated presently, but that it has been very significant can not be denied. Further support of the significance of effective environmental control in promoting the public health even to-day was presented at the convention of the American Public Health Association in New York in 1937 by Dr. Livingston Farrand, president-emeritus of Cornell University, who said at one of the great general meetings that "the two outstanding public health problems in the United States to-day are housing and nutrition." The first includes the elimination of slums and low standard housing areas and their replacement with suitable housing facilities; while the second deals with the important problem of providing an adequate and properly balanced diet for every man, woman and child. Both factors affect the public health through their influence on the vital resistance of the individual; while the housing factor also plays a rôle in his comfort and happiness.

In addition to the work of the public health engineer various other factors have played important parts in the public health progress that has been made since 1880. During this period, bacteriology has blossomed into a highly developed science. Not only have many of the etiological agents of disease been determined, but numerous laboratory aids in the diagnosis of disease have been developed. These have assisted greatly in making early and definite diagnoses—a prerequisite

[11] Abel Wolman, *Am. Jour. Public Health*, 27: 1, 43–49, January, 1937.

[12] Charles Gilman Hyde, *Am. Jour. Public Health*, 26: 7, 697–710, July, 1936.

to effective treatment and even to the prevention of secondary cases in certain diseases.

Another factor has been the development of biological products for the diagnosis, prevention and treatment of certain diseases. It is unnecessary to list all of them here, since the student of public health is quite familiar with them; but typhoid vaccine, smallpox vaccine, toxoid, antitoxin, anti-pneumococcus serum and various other biological agents are well known tools in the prevention and control of disease. Biological therapy will doubtless be replaced eventually by chemo-therapy, for through the activities of the biochemist and the organic chemist the structure and composition of immune substances and immunizing agents will be determined and subsequently synthesized outside the body. Already some of the vitamins and hormones have been synthesized and specific chemical substances are available for the treatment of specific diseases. The chemist and physicist are destined to make important contributions to our understanding of the mechanism of immunity and the composition of immunizing substances.

Still another factor that has played a part in the public health progress of the past 60 years has been the work of the statisticians. They have determined death rates and their trends. They have determined specific death rates for every cause of death and have analyzed these rates by age, sex, nativity, color, racial origin, occupation, economic status, religious affiliation, ward of residence, illiteracy and various other factors. In this way, a vast amount of epidemiological information has been assembled and utilized in planning the public health campaign. It has meant that the available funds could be spent more wisely and effectively.

Still another factor which has played a significant but unmeasurable rôle in the public health progress of the past 60 years has been the great campaigns of personal and popular health education. These campaigns have dealt with hygienic living; with the need for immunization against diphtheria, typhoid fever and smallpox; with the requirements of an adequate and properly balanced diet; with the importance of consuming milk in adequate amounts, especially pasteurized milk; with pure water; with proper excreta disposal; with the importance of controlling flies, mosquitoes and other insects as well as rodents; with the importance of dental care and early diagnosis in the detection of tuberculosis; with prenatal hygiene, infant and child hygiene; with the abatement of housing evils and atmospheric pollutions; with the importance of detecting and eliminating physical defects and the desirability of periodic, competent medical examinations. Campaigns of education have been waged against cancer, organic heart disease, the genito-infectious diseases and various other important human maladies. These campaigns have been waged in the public press, through other printed material, through lectures and demonstrations, through classes and through the aid of the public health nurse in the home and clinic. Attending physicians at clinics have frequently aided in this program of enlightenment. The public schools have been literally bombarded with health educational material, and the curriculum has been modified to include instruction in the essentials of healthy living. Such a campaign, conducted on so gigantic a scale, and one which has been so persistent must have had some effect, even though its magnitude is not measurable. Its potential value is appreciated by every progressive health officer and public health worker.

Since the tools of public health education consist of the printed and spoken word, pictures and demonstration material, and the intelligent use of scientific information coupled with a knowledge of mass psychology, this significant contribution to public health progress may also be considered an aspect of environmental control.

It is relatively simple to account for the great progress in the control of the intestinal and insect-borne diseases through the more effective control of the environment. It is also a simple matter to account for the control of such diseases as diphtheria and smallpox through the extensive use of suitable biological products for prevention, diagnosis and treatment. How can we account for the remarkable progress against tuberculosis? For tuberculosis is a respiratory disease very largely, and there has not been available a specific biological agent for immunizing susceptible individuals or treating those who are ill. Recently, of course, the developments of new surgical technique have made it possible to place a diseased lung at rest, a practice which has proven even more efficacious in hastening the healing process than bed rest. It is important to remember, however, that much of the great progress against tuberculosis occurred before the advent of surgical aids in the treatment of this disease. Accordingly, it is important to look for other causes to explain this remarkable phenomenon.

There are very few diseases that are so intimately linked up with the vital resistance of the body as tuberculosis. The rise in the mortality from tuberculosis during the World War in Austria, Germany, England and France lends support to this view. Doubtless the improvement in all the environmental factors affecting health—such as more adequate and complete nutrition; safe water supplies; pasteurized milk supplies; clean, wholesome, safe foods; increased sewerage facilities; shorter working hours; better working conditions; vacations and rest periods; health education; better housing; and the improvement in general health and vitality

following the more effective control of other diseases—has had its beneficent effect on the prevalence and mortality from tuberculosis. This does not minimize the importance of the development of laboratory aids in the diagnosis of tuberculosis and of the establishment of tuberculosis clinics for the early diagnosis of the disease and of sanatoria and hospitals for the effective treatment of the disease. But it does indicate quite definitely that the more effective control of the environment has played a part, and in all probability a large part in the progress made against tuberculosis.

Recently[13] the *Journal* of the American Medical Association, quoting from a study by Georg Wolff on "Tuberculosis and Civilization," published in *Human Biology* for May, 1938, lists five of the possible factors that have reduced the mortality from tuberculosis in the last 50 years from approximately 300 per 100,000 population to 50 per 100,000 population. The factors enumerated are: (1) a specific factor; (2) an hereditary factor; (3) a social factor; (4) a population factor; and (5) a medical prophylactic factor. Of these, the social factor is considered the most important and the items enumerated under this heading include improvement in economic well-being; better housing; better nutrition; better working conditions; smaller families; and hygienic education. As noted above, these factors are aspects of the environment of man, the improvement of which has been a fundamental cause in his superior well-being.

Phenomenal progress in preventing disease and premature mortality has also been made among infants and pre-school children. It is therefore desirable to inquire into the factors that have been largely responsible for the saving of human life in these very vulnerable age groups. An analysis of the statistical data available points very definitely to the fact that the control of the environment has been the dominant factor. Dublin and Lotka[14] show that in New York City in 1872 the death rate from diarrhoeal diseases under 5 years of age was equal to 40 per 1,000 of the population under 5 years; whereas by 1931, the death rate from this cause was down to 1 per 1,000. This remarkable improvement in the control of diarrhoeal diseases in children is due to the better control of all the environmental factors involved as well as the introduction of more scientific feeding. The control of diarrhoeal diseases in children alone would account for much of the life saving that has been witnessed in this group. If to this factor be added the saving of human life due to biological products used for prevention, diagnosis and treatment, and the improvement in the robustness of children due to improved hygiene, the significance of an improved environment on human welfare becomes more apparent.

If the factors responsible for the diminution of infant mortality be studied, a similar conclusion results. Dublin and Lotka[15] show the trend in infant mortality by cause for the U. S. Birth Registration States of 1917 for the period 1917–1932. The authors conclude that "the great gain that has been scored in preserving infant life has been due very largely to our success in dealing with this one item of diarrhea and enteritis. A large number of factors have undoubtedly contributed to the great improvement which has taken place in the mortality from this disease. Among the contributing factors should be mentioned particularly the introduction of the compulsory pasteurization of milk and the increasing spread and the greater perfection of methods of refrigeration; the education of mothers regarding the proper feeding of infants; attention to cleanliness of food and the avoidance of unripe fruit; the improvement in the quality of public and domestic water supplies; and the general awakening to the menace of flies as carriers of disease."

If infant mortality is studied by months, it will be found that approximately 60 per cent. of all infant deaths occur during the first month of life, and most of these during the first week of life. These infant deaths are most closely associated with the lack of suitable prenatal and obstetrical care and have shown remarkable constancy in some cases, while in others the rates have actually gone up. Infant death rates due to syphilis, congenital malformations, influenza and pneumonia, premature birth, whooping cough and bronchitis and broncho-pneumonia have either remained stationary or have receded very, very slowly, while the infant death rate due to injuries at birth has actually increased. Only recently have the neonatal infant mortality rates begun to come down in those enlightened and progressive communities where special campaigns have been waged.

Finally, the practice of medicine has undoubtedly played a part in the splendid public health achievement of the past 50 or 60 years. Surgery, aided by antisepsis and asepsis, by x-ray photography and by advances in our knowledge of general physiology, has unquestionably saved the lives of countless thousands of ailing humans. It has also promoted the comfort and well-being of other countless numbers whose lives were not in jeopardy. Improvement in laboratory diagnostic techniques as well as the establishment of public health clinics and outpatient department services have promoted the early diagnosis of disease which in turn has made it possible to place the patient under prompt and effective treatment in many cases. Good nursing has also done its share in helping the

[13] *Journal, Am. Med. Asn.*, 111: 11, 1020–1021, September 10, 1938.

[14] *Loc. cit.*, p. 156.

[15] *Ibid.*, p. 163.

body recover a state of health after medical treatment had been provided. The conclusion that can be drawn from this exposition is that the great public health achievements of the past 50 years are the result of the joint efforts of engineers, social workers, physicians, dentists, nurses, statisticians, epidemiologists, health educators, public health administrators, chemists, physicists, sanitary biologists and doubtless many others. Public health progress is emphatically not due to the activity of any one professional group.

Now that many of the communicable diseases have been brought under control by the methods described in the previous section, and such diseases as organic heart disease, cancer, nephritis, arterio-sclerosis, diabetes and other degenerative diseases have assumed increasing importance because of their high mortality, it is interesting to inquire how further public health progress is likely to be made. It is obvious that in so far as focal infections and communicable diseases are associated with the etiology of the degenerative diseases, their early discovery and elimination through expert medical service is of great value. Unfortunately, the degenerative diseases and cancer affect the population during the later adult periods of life and are apparently the result of physiological derangements of the human mechanism, the causes of which are still unknown. Early diagnosis and effective medical treatment in these degenerative diseases of later adult life may be palliative, but as yet they have not been successful in prolonging life to any appreciable degree. In order to accomplish this desirable end it is necessary to know how and why the degenerative diseases have their onset and to determine the best methods of prevention and control. Why does the body grow old and show the well-known symptoms of degeneracy and decay? What takes place within the body cells when senescence occurs? What keeps cancer in check during the early years of life in most cases and what occurs in the body later on in the very same human beings? The answers to these questions can not be found in the public health or hospital clinics. The answers must be found in the research laboratories, through the work of chemists, physicists, biochemists, organic chemists, bio-physicists, physiologists and other highly trained men in the various fields of science. In other words, further progress in prolonging the average life span of man at birth must depend on the significant contributions emerging from the various research laboratories.

At the present time, the evidence seems clear that those who reach the mature age of 80 years or more have usually come from long-lived parents. Such people seem to be able to overcome the hazards which are frequently fatal to those of shorter-lived ancestry. Heredity seems to play a far more important role in determining longevity than many of the factors normally regarded as significant. The effect of heredity on longevity is indicated by the data in Table 5.

TABLE 5

EFFECT OF PATERNAL HEREDITY ON LONGEVITY OF SONS[16]

Age of son at death, in years	Per cent. having fathers who died at age 80 or over
Under 20	24
20–39	21
40–59	27
60–79	38
Over 80	46

Great emphasis is being placed in the current public health campaign on the control of the genito-infectious diseases and pneumonia. Control, however, in these diseases is also based on the use of certain laboratory procedures for diagnosis, and on either chemo or sero therapy. It is apparent therefore that suitable control of the environment, including health education, also plays a rôle in the control even of these diseases.

The preceding analysis has brought out, I believe, the significance of the more effective control of the environment on the prevention of disease and premature mortality and on the prolongation of the average life span at birth. Coupled with a declining birth rate and with the restrictions that have been placed on immigration, the population of the United States has been growing older. This is evident from the larger proportion of the population now found in the later age groups. Older people must have and insist upon having a comfortable environment. Accordingly, the public health movement of the immediate future is destined to see greater emphasis on the comfort and convenience of man as well as a continuing emphasis on the prevention and control of disease. The former will undoubtedly include air conditioning, noise abatement, improved housing, smoke abatement, clean streets, parks and recreation centers, abatement of nuisances due to odors and unsightly conditions, stream purification and other items that fall within the realm of activity of the public health engineer. It would seem therefore that the importance of the public health engineer in organized community life is destined to increase rather than diminish.

SCIENTIFIC EVENTS

THE CONVERSAZIONE OF THE ROYAL SOCIETY

THE Royal Society held the first of its two annual conversaziones in its rooms at Burlington House, London, on May 24, when as usual a number of exhibits were displayed.

The London *Times* states that prominent among the

[16] *Ibid.*, p. 139.

exhibitors were various departments of the British Museum. Its department of zoology sent a series of armadillos, an example of camouflage in a nightjar and turtles stranded on the coasts of the British Isles; its department of geology flexible sponges of Oligocene age from Ukraine and casts of the skull and other parts of a large fossil amphibian from New South Wales; and its department of mineralogy a beautiful specimen of Danburite, a rare gem stone from Burma; while its research laboratory and department of ethnography illustrated the application of x-rays to the study of old Peruvian pottery.

From Kew Gardens came specimens showing the resupination of the flowers of laburnum and other plants, and the origin of the garden plum was illustrated by the John Innes Horticultural Institution. The National Physical Laboratory showed radio-transmitting equipment for use with meteorological sounding balloons, and an apparatus for measuring extremely minute differences in water pressure, and the Cavendish Laboratory, Cambridge, a new form of x-ray microscope which converts a series of measurements on x-ray beams diffracted by a crystal into an optical image of the crystal that can be viewed through an eyepiece.

Among exhibits from the Imperial College of Science and Technology were instruments for the microscopy of ores, a small internal-combustion engine running on methane and apparatus for measuring the oxygen consumption of flying insects and determining the effect of atmospheric pressure on the frequency of their wingbeat.

The director of research of the Admiralty demonstrated the rapid spectro-chemical analysis of alloy steels, and Dr. W. H. Hatfield, of the Brown-Firth Research Laboratories, showed non-magnetic steels and examples of different methods of obtaining extremely hard metallic materials. Sir Robert Hadfield showed a quick-immersion thermo-electric pyrometer for measuring the temperature of liquid steel and apparatus for the rapid estimation of carbon in steel.

Photographic exhibits sent by George H. Gabb included examples of early Talbotypes and Daguerreotypes, among them being what is probably the earliest attempt to photograph the solar spectrum, dating from 1842.

A CONFERENCE ON THE CALCULUS OF VARIATIONS

A CONFERENCE on the calculus of variations will be held at the University of Chicago from June 27 to 30 under the auspices of the department of mathematics. The speakers and the topics which will form the basis for discussion at the conference are as follows: Tibor Rado, of Ohio State University, "Length and Area" and "Geometrical Approach to the Plateau Problem"; Jesse Douglas, of the Institute for Advanced Study, "The Problem of Plateau-Riemann" and "Minimal Surfaces of Higher Topological Structure"; Marston Morse, of the Institute for Advanced Study, "Functional Topology and Analysis in the Large" and "The Existence of Minimal Surfaces of General Critical Type"; Karl Menger, of the University of Notre Dame, "Logical Analysis of the Semi-continuity Properties of Line Integrals"; E. J. McShane, of the University of Virginia, "Existence Theorems for Minima of Simple and of Multiple Integrals"; Max Coral, of Wayne University, "The Equations of Haar and the Differentiability of their Solutions"; G. A. Bliss, of the University of Chicago, "The Field Theory for Multiple Integrals"; L. M. Graves, of the University of Chicago, "The Jacobi Condition for Minima of Multiple Integrals"; M. R. Hestenes, of the University of Chicago, "The Problem of Bolza"; W. T. Reid, of the University of Chicago, "Sufficiency Proofs for the Calculus of Variations by Expansion Methods"; H. H. Goldstine, of the University of Chicago, "Minimum Problems of Abstract Functional Calculus." Discussion of some of the problems and results presented in the lectures of the conference will be continued in a seminar on the calculus of variations conducted by G. A. Bliss, and lasting through the summer quarter. Among those who will participate in the seminar are Max Coral, H. H. Goldstine, L. M. Graves, M. R. Hestenes, E. J. McShane, W. T. Reid and M. F. Smiley. A series of lectures preparatory to the addresses of the conference will be given in the seminar in the preceding week, from June 21 to 24. All mathematicians and other scientists who may be interested are cordially invited to attend the conference and the preparatory lectures in the seminar. Requests for information concerning the conference and housing accommodations may be addressed to Professor M. R. Hestenes, Eckhart Hall, University of Chicago.

L. M. GRAVES

THE ATLANTIC CITY MEETING OF THE AMERICAN SOCIETY FOR TESTING MATERIALS

THE forty-second annual meeting of the American Society for Testing Materials will be held at Chalfonte-Haddon Hall, Atlantic City, from June 26 to 30. There will be given upwards of a hundred and ten technical papers and reports in the fields of standardization, research and testing of engineering materials. The subject of the annual address of the president, T. G. Delbridge, manager of the research and development department of the Atlantic Refining Company, will be "Glimpses at Petroleum," and the fourteenth Edgar Marburg Lecture will be by Professor H. F. Moore, on "Stress, Strain and Structural Damage."

Throughout the week of the meeting the fifth Exhibit of Testing Apparatus and Related Equipment will be in progress. The exhibit will open at noon on Monday. Many leading commercial companies concerned with the manufacture and distribution of testing apparatus and related equipment, measuring and recording instruments, laboratory supplies and related scientific instruments will be among the exhibitors. A number of instruments will be on display for the first time. In addition, several committees of the society are sponsoring displays illustrating important parts of their work. There will also be in progress the second Photographic Exhibit and Competition on the theme "Testing and Research in Engineering Materials." A separate section will be given to photomicrography.

On Monday the whole day will be devoted to committee meetings, which will continue through the remainder of the week. The first formal session will open at 10:30 o'clock on Tuesday morning, June 27. The second session in the afternoon, a Symposium on Paint Testing, with ten to twelve informal papers covering particular tests and their significance, will be held simultaneously with the one on iron, including several papers on cast iron and malleable iron castings. Two evening sessions on Tuesday are devoted to water, with five technical papers and two reports on this subject; and a round-table discussion of effect of subatmospheric temperatures on the properties of metals.

The session on Wednesday morning will be devoted to paper, plastics, rubber, glass and electrical insulating materials. This session runs concurrently with the one on fatigue and corrosion, there being four items dealing with fatigue and five covering corrosion. Reports on soaps, textiles and timber will follow on Wednesday afternoon, with a simultaneous session on coal, petroleum products and gaseous fuels. The Edgar Marburg Lecture will be given on Wednesday at 4 P.M., and at this time the award of the Charles B. Dudley Medal will be made. The evening session covers radiography, magnetic testing and metallography, there being four items in the field of radiographic testing by well-known authorities. At the time there will be a session dealing with soils, with a symposium on Shear Testing of Soils. Six papers by prominent technologists form the basis of discussion.

Thursday morning will be devoted to steel, ferroalloys and the effect of temperature. Two other sessions run concurrently with this—one on bituminous materials and road materials and the other round-table discussion on quantitative spectrography. A round-table discussion on Thursday afternoon on freezing-and-thawing tests will determine whether any organized work should be undertaken by the society in this field. The fourteenth session involves ceramic and masonry materials. Several papers will be given at the fifteenth session on methods of testing. Discussions will concern cement, concrete, lime and gypsum. The concluding session will include twelve papers and reports on non-ferrous metals.

THE GEOLOGICAL SOCIETY OF AMERICA

THE Geological Society of America, Section E of the American Association for the Advancement of Science, the Association of American Geographers and the American Society of Agricultural Engineers will join in meetings at Milwaukee during the week of June 19. The Upper Great Lakes region will provide the general theme for scientific sessions and excursions.

The following excursions have been arranged:

June 15–17. To the iron and copper districts of northern Michigan, leaving Marquette, Michigan, 8 A.M., June 15. R. M. Dickey, leader.

June 19–22. Local trips, with Milwaukee as base. Ira Edwards and F. T. Thwaites, leaders.

June 24–27. To the Baraboo-Devils Lake region, Wisconsin. E. F. Bean, leader.

Those interested in participating in the excursion to northern Michigan or in the excursion to the Baraboo region, Wisconsin, are asked to communicate with the Secretary of the Section, H. A. Meyerhoff, 88 Crescent Street, Northampton, Mass. Plans were made on the basis of the registration on June 1, although later registration is not precluded.

The program and abstracts of papers to be presented at the summer meeting to be held at the University of California, Berkeley, on August 8, 9 and 10, will be distributed in June. Those wishing to participate in the local excursions on August 10 and from August 11 to 14, and in the excursion arranged for Los Angeles on August 17, who have not already sent in their names, are urged to communicate at once with C. A. Anderson, secretary of the Cordilleran Section, University of California, Berkeley.

As previously announced, the Paleontological Society, the Society of Economic Geologists and the Seismological Society of America will hold meetings at Berkeley in conjunction with the meeting of the Geological Society.

SEVENTH INTERNATIONAL CONGRESS OF GENETICS

PLANS for the Seventh International Congress of Genetics, to be held from August 23 to 30 in Edinburgh, are now fairly complete. The meetings will be held in the university departments at King's Buildings on the outskirts of the city. The Organizing Committee has selected Dr. N. I. Vavilov as president of the congress, and the secretary-general is Professor F. A. E. Crew, of the Institute of Animal Genetics at Edinburgh.

The sectional programs with their recorders will include the following:

A. "Gene and Chromosome Theory": H. J. Muller, Edinburgh.
B. "Cytology": C. D. Darlington, Merton Park.
C. "Physiological Genetics": B. Ephrussi, Paris.
D. "Animal Breeding in the Light of Genetics": A. D. Buchanan Smith, Edinburgh.
E. "Plant Breeding in the Light of Genetics": K. Mather, Merton Park.
F. "Human Genetics": G. Dahlberg, Uppsala.
G. "Genetics in Relation to Evolution and Systematics": J. S. Huxley, London.
H. "Statistical Genetics": R. A. Fisher, London.
I. "Genetical Aspects of Growth, Normal and Abnormal": C. C. Little, Bar Harbor.

A pre-congress tour from London to Edinburgh by motor bus has been arranged. The party will meet in London on Tuesday, August 15. Wednesday and Thursday will be spent in visiting various university departments and research institutions. On Friday the party will go to Cambridge by motor coach, there to spend the afternoon and the whole of Saturday in visiting the university departments, colleges and research institutions. On Sunday the party will leave for Chester, traveling through typical English scenery to reach this city steeped in historic associations. On Monday the journey will end at Windermer, the center of the English lake district. On Tuesday the party will cross the border at Carlisle, travel through the border hills, and reach Edinburgh in the late afternoon.

Several post-congress tours have also been arranged. These comprise three-, four-, five- and six-day tours in the lake regions of Scotland.

During the week of the congress a number of social functions have been arranged; *e.g.*, reception by the city of Edinburgh; congress banquet in the library hall of the university; visits to art galleries, museums and places of historic interest, etc.

Approximately sixty American geneticists have signified their intention to attend the congress. The Genetics Society of America is aiding in travel arrangements for their members and guests. (General travel information may be had from the secretary, E. W. Lindstrom, of the Iowa State College, Ames, Iowa.) Members planning to ship exhibit material requiring customs or quarantine inspection should write the representative of the society, Dr. M. M. Rhoades, Arlington Farm, U. S. Department of Agriculture, Arlington, Va.

RECENT DEATHS

DR. DAVID TODD, emeritus professor of astronomy and navigation and director of the observatory of Amherst College, died on June 1. He was eighty-four years old.

DR. EDWIN LINTON, professor emeritus of biology of Washington and Jefferson College, died on May 5 at the age of eighty-four years.

DR. JOSEPH GRINNELL, professor of zoology and director of the Museum of Vertebrate Zoology at the University of California, died on May 29 at the age of sixty-two years.

DR. CHARLES FREDERICK LORENZ, consulting engineer, from 1910 until his retirement in 1930 a member of the departments of physics of the Nela and the Westinghouse Research Laboratories, died on May 30 at the age of sixty-four years.

DR. ALFRED FRIEDLANDER, professor of medicine and dean of the College of Medicine of the University of Cincinnati, died on May 28 at the age of sixty-seven years.

DR. E. ROSS FAULKNER, for sixteen years surgical director of the Manhattan Eye, Ear and Throat Hospital, died on May 29 at the age of sixty-three years.

A CORRESPONDENT writes: "Alfred W. Anthony, ornithologist, died in San Diego, Calif., on May 14 at the age of seventy-three years. He was one of the pioneer field naturalists of the West, his collections being preserved in several museums. Between 1920 and 1923 he served as director and as curator of vertebrates on the staff of the San Diego Natural History Museum."

SCIENTIFIC NOTES AND NEWS

THE autumn meeting of the National Academy of Sciences will be held at Brown University on October 23, 24 and 25. The address of welcome will be made by Dr. Henry Merritt Wriston, president of the university, and the response will be made by Dr. Frank B. Jewett, president of the Bell Telephone Laboratories, who was elected president of the academy at the spring meeting. Members of the committee on arrangements are: W. S. Hunter, *chairman*, P. H. Mitchell, R. B. Lindsay, C. A. Kraus, R. G. D. Richardson, W. H. Snell and F. E. Wright (*ex-officio*).

AT the commencement exercises of the Case School of Applied Science the doctorate of science was conferred on Dr. Clement C. Williams, president of Lehigh University, formerly dean of engineering at the University of Iowa, who gave the principal address, and on Dr. Otto Struve, director of the Yerkes and McDonald Observatories. The doctorate of engineering was conferred on M. Y. Seaton, chief engineer of the California Chemical Corporation.

DR. W. G. CROCKETT, professor of pharmacy at the Medical College of Virginia, was awarded the hon-

orary degree of doctor of science by Hampden-Sydney College at the final exercises of that institution on June 6.

DR. THOMAS S. ROBERTS, professor of ornithology and director of the Museum of Natural History of the University of Minnesota, has been awarded the Brewster Medal by the American Ornithological Union "for the most meritorious work on American birds." The medal was presented to Dr. Roberts in Washington, D. C., for the second edition of his "The Birds of Minnesota."

THE council of the Royal Society of Tropical Medicine and Hygiene at its last meeting awarded the Chalmers Gold Medal for 1939 to Dr. Max Theiler, of the International Health Division of the Rockefeller Foundation, New York, "in recognition of research of outstanding merit contributing to the knowledge of tropical medicine or tropical hygiene, particularly in reference to yellow fever and the possibility of producing the vaccine by the use of attenuated virus." The medal will be presented at the annual general meeting of the society at Manson House, London, on June 15.

THE following were elected honorary fellows of the Royal Society of Medicine on May 16: *British Honorary Fellows:* Professor William Bulloch and Sir Cuthbert Wallace. *Foreign Honorary Fellows:* Dr. Alexis Carrel, New York; Professor C. G. Jung, Zurich; Professor Charles Laubry, Paris; Dr. Max Neuburger, Vienna, and Professor J. Schoemaker, The Hague.

THE Anna Fuller Memorial Prize of $7,500 for cancer research has been awarded for the first time to a group of five scientific men of the Research Institute of the Royal Cancer Hospital, London. It will be shared equally by Ernest Laurence Kennaway, director of the institute; James Wilfrid Cook, Colin Leslie Hewett and Izrael Hieger, chemists; and William Valentine Mayneord, physicist. The award is made upon the recommendation of the president of the American Medical Association, Dr. Irvin Abell; the dean of the Johns Hopkins Medical School, Dr. Alan M. Chesney; and the dean of the Harvard Medical School, Dr. C. Sidney Burwell.

PROFESSORS J. P. MOORE and P. P. Calvert, of the department of zoology of the University of Pennsylvania, will retire at the end of the present academic year. On the evening of May 31, their present and former students and associates held a dinner in their honor at the Hotel Normandie, in Philadelphia. Dr. Josiah H. Penniman, who retires this month as provost of the university, presided, and Dr. Edwin G. Conklin, executive vice-president of the American Philosophical Society, gave the principal address. More than a hundred guests were in attendance. Professor Moore was presented with a microscope and Professor Calvert with special equipment for his microscope. A large portrait photograph of each, suitably framed, was presented to the university to be hung in the Zoological Laboratory.

DR. WORTLEY F. RUDD, dean of the school of pharmacy of the Medical College of Virginia, was made president-elect of the Virginia Academy of Science at its annual meeting, which was held in Danville from May 4 to 6.

AT the annual meeting of the American Society of Clinical Pathologists in St. Louis on May 12 Dr. L. W. Larson, Bismarck, N. D., was inducted into the office of president for the coming year. Officers were elected as follows: *President-elect,* Dr. A. V. St. George, New York; *Vice-president,* Dr. C. L. Klenk, St. Louis; *Secretary-treasurer,* Dr. A. S. Giordano, South Bend, Ind.; members of the *Executive Committee,* Dr. T. B. Magath, Rochester, Minn., and Dr. F. W. Konzelmann, Philadelphia; of the *Board of Censors,* Dr. F. B. Queen, Chicago, and Dr. W. R. Mathews, Shreveport, La.; and of the *Board of Registry,* Dr. A. H. Braden, Houston, Texas, and Dr. J. B. McNaught, San Francisco, Calif. The Ward Burdick award was presented to Dr. Harry Goldblatt, Cleveland, for his work on Arterial Hypertension; the scroll for meritorious service was awarded to Dr. Philip Hillkowitz, of Denver, and the Gold Medal for excellence in the scientific exhibit was awarded to Drs. S. E. Ziffren, C. A. Owen, G. R. Hoffman and H. P. Smith, of Iowa City.

DR. JAMES MARSHALL HANNA ROWLAND, dean of the Medical School of the University of Maryland for the past twenty-four years, will retire with the title dean emeritus at the close of the present academic year.

DR. EMIL PETER SANDSTEN, director of the Agricultural Experiment Station and dean of agriculture of Colorado State College at Fort Collins, will retire with the title of emeritus on July 1. Dr. Sandsten will be succeeded by Dr. Charles H. Kick.

DR. OTTO DUNKEL, of the department of mathematics and astronomy of Washington University, St. Louis, will retire this June after having served as a member of the faculty for twenty-three years.

ANTOINE M. GAUDIN, research professor of mineral dressing at the Montana School of Mines at Butte, an authority on process metallurgy, has been appointed Richards professor of mineral dressing at the Massachusetts Institute of Technology.

DR. DONALD H. MENZEL, associate professor of astrophysics at Harvard University, has been promoted to a professorship.

CARL-G. A. ROSSBY, head of the department of meteorology of the Massachusetts Institute of Technology, has been appointed to the newly established position of assistant chief for research and education in the U. S. Weather Bureau. He has leave of absence from the institute for three years.

DR. A. A. BLAIR, who has been assistant fishery biologist at the Solomon's Island Marine Biological Laboratory, Maryland, has resigned to accept a post with the Government of Newfoundland, where he will take charge of fishery investigations.

THE Committee on Scientific Research of the American Medical Association has made a grant to Dr. Warren O. Nelson, professor of anatomy at Wayne University, for the continuation of studies on the thymus gland. The present grant extends the assistance which the committee has given during the past eighteen months.

DR. HENRY E. SIGERIST, professor of the history of medicine at the Johns Hopkins School of Medicine, sailed on May 30 for Europe and will later go to South Africa. He expects to return to Baltimore early in December. While in Europe Dr. Sigerist will attend an international conference on socialized medicine from June 23 to 25 at Liège, Belgium. In South Africa, from August until the middle of November, he will deliver a course of twenty-five lectures in each of ten institutions.

DR. E. A. ROVENSTINE, professor of anesthesia at the New York University College of Medicine and director of the Division of Anesthesia at Bellevue Hospital, sailed on June 1 for South America. He will present a series of demonstrations and lectures on anesthesia to medical schools in Santiago and Concepcion, Chile, and in Buenos Aires and Rosario, Argentina. He expects to return late in July.

DAVID LACK, leader of the Lack-Venables Expedition to the Galapagos Islands under the auspices of the Royal and London Zoological Societies, has arrived in San Francisco with thirty living specimens belonging to four species of endemic Galapagos finches. The original plan was to take these birds to London for experimental breeding studies. Having reached Panama, however, with the birds in only fair condition, Mr. Lack feared that they would not survive the trip to England. Accordingly, with the approval of Dr. Julian Huxley, arrangements were made by cable to transfer the whole problem to the California Academy of Sciences, where the breeding experiments will be conducted by Dr. Robert T. Orr, assistant curator of birds and mammals.

PROFESSOR AUBREY J. KEMPNER, on the recommendation of the Council on Research of the University of Colorado, gave the annual research lecture on May 15. He spoke on "What is the Nature of Mathematics, and in what Sense does Mathematics Explain a Science?" The lecture was given in Boulder, the fourth in the series of annual lectures established to honor research workers and give public recognition to the research activities of faculty members.

DR. OTIS W. CALDWELL, general secretary of the American Association for the Advancement of Science, gave the commencement address at the Medical College of Virginia, Richmond.

DR. OSCAR RIDDLE, of the research staff of the Station for Experimental Evolution of the Carnegie Institution at Cold Spring Harbor, N. Y., gave an address on May 8 before the Mayo Foundation, Rochester, Minn., on "Some Products and Performances of the Anterior Pituitary Gland."

THE last week of June at Stanford University will be devoted to meetings of the Pacific Division of the American Association for the Advancement of Science, including on Friday afternoon a symposium on x-rays and molecular structure. The Centenary Symposium on the Cell and Protoplasm is from June 30 to July 5. The last day, with addresses by O. L. Sponsler, L. V. Heilbrunn and J. D. Bernal, and a garden party at the home of Professor and Mrs. McBain, leads up to the National Colloid Symposium, which meets from July 6 to 8 with a program of twenty-eight papers. The guest of honor is J. D. Bernal, F.R.S., of the University of London.

THE University of Wisconsin Medical School will conduct an Institute for the Consideration of the Blood and Blood-Forming Organs from September 4 to 6. The program will include papers and round-table discussions by European and American workers in the field of hematology. In addition to the discussions a program of formal papers will be presented. The speakers will include: Dr. L. J. Witts, Oxford, England; Dr. Cecil J. Watson, Minneapolis; Dr. Cornelius P. Rhoads, New York; Dr. E. Meulengracht, Copenhagen, Denmark; Dr. Harry Eagle, Baltimore; Dr. George R. Minot, Boston; Dr. Russell L. Haden, Cleveland; Dr. Jacob Furth, New York; Dr. Claude E. Forkner, New York; Dr. Edward B. Krumbhaar, Philadelphia; Dr. Louis K. Diamond, Boston; Dr. Edwin E. Osgood, Portland; Dr. Charles A. Doan, Columbus; Professor Hal Downey, Minneapolis, and Dr. Paul Reznikoff, New York. A detailed program may be obtained by addressing Dr. Ovid O. Meyer, chairman of the Program Committee, University of Wisconsin Medical School, Madison, Wis.

A GROUP of courses will be given during the summer session of the University of Pittsburgh from July 6 to August 1 on the "Physics of Metals." An attempt will be made to understand the nature of the forces

which make pure metals and alloys hard or soft, ductile or brittle, good or bad conductors of electricity, etc. Courses will be offered by Dr. John C. Slater, head of the department of physics, the Massachusetts Institute of Technology; Dr. M. F. Manning, University of Pittsburgh; Dr. William Shockley, the Bell Telephone Laboratories; Dr. Frederick Seitz, University of Pennsylvania; Dr. Edward U. Condon, associate director, the Westinghouse Research Laboratory. A booklet describing these courses has been prepared, and may be obtained by writing to Professor E. Hutchisson, University of Pittsburgh.

SIGMA PI SIGMA, physics honor society, installed a new chapter at Wayne University, Detroit, on May 22. Dr. F. C. Blake, of the Ohio State University, national president; Dr. M. W. White, of the Pennsylvania State College, national executive secretary; and Dr. C. W. Chapman, of the Michigan State College, were the installing officers. Following the installation banquet an open meeting was held, which was addressed by Dr. P. E. Klopsteg, of the Central Scientific Company, Chicago, who spoke on "Scientific Aspects of Archery."

CORNELL UNIVERSITY announces the establishment at Ithaca of a Summer Research Station in Psychology. Beginning this summer, facilities will be available, without fees, for experimental research, library research and informal study, to investigators holding the doctor's degree. Information concerning laboratory facilities and living accommodations may be obtained from the Secretary of the Department of Psychology, Cornell University, Ithaca, N. Y.

THE University of Missouri has received a grant of $80,000 for the erection of a building for the Laboratory of Genetics from the Division of Natural Sciences of the Rockefeller Foundation and an additional grant of $20,000 for the continuation of research projects now being carried on by Dr. L. J. Stadler, professor of field crops, and Dr. Barbara McClintock, assistant professor of botany, and their associates. Their work has hitherto been supported by the Rockefeller Foundation, the Missouri Agricultural Experiment Station, the U. S. Department of Agriculture and from general university funds.

THE National Foundation for Infantile Paralysis has approved a grant of $161,350 for the establishment of an infantile paralysis center for Negroes at the Tuskegee Institute, Alabama. The money will be used to build, equip and maintain for one year a center of thirty-six beds. The construction of the building will be started without delay.

DR. STUART T. DANFORTH, formerly a professor at the College of Agriculture at Puerto Rico, has bequeathed to the Smithsonian Institution one of the most complete collections yet made of birds of the West Indies. It consists of more than 3,000 specimens. Dr. Danforth spent approximately thirteen years in gathering this collection, which contains not only all the common forms of the islands, but some of which there are only a few specimens in existence.

THE Institute for Advanced Study at Princeton has been declared exempt from taxation by the State Board of Tax Appeals. The property on which the institution is located was assessed for $9,625 in 1937 and the Mercer County Tax Board denied a claim to exemption from taxation. The institute appealed to the state board to reverse the decision. In rendering this decision the state board pointed out that the institution makes no charge to students and, in some instances, subsidizes competent persons otherwise unable to take advantage of its resources, and that the property is used exclusively for non-profit-making, educational purposes.

DISCUSSION

MICRO-COPEPODA IN MARINE PHYTOPLANKTON CATCHES[1]

IN 1938 the Scripps Institution of Oceanography made six cruises (February, April, June, August, October and December) off the coasts of California in pursuit of hydrographical, chemical and biological investigations. Thirty-one stations were worked on each cruise except for minor changes and except for omission of about half in April on account of bad weather. On each cruise five liter samples of water for phytoplankton researches were collected with the Allen closing bottle and filtered through the Allen filtration net of No. 25 mill silk bolting cloth. Except for Cruise II (six levels only) collections were made at seven levels at each station (surface, 10, 20, 30, 40, 50, 60 meters).

While making routine microscopical studies of the phytoplankton I was struck by the constancy of representation of copepods less than two millimeters in length (most less than one millimeter). One female carrying twenty-five eggs was .85 mm long and one carrying fifteen eggs was .76 mm. Some of the nauplii were only about .15 mm long; surpassed in dimensions by a few of the diatoms and dinoflagellates with which they were associated.

By the time that I had studied about a thousand

[1] Contribution from the Scripps Institution of Oceanography, New Series, No. 56.

catches I got the idea that this copepod population deserved some special notice. Using my Sedgwick-Rafter counting cell I enumerated the micro-copepoda in one tenth of each catch and calculated the numbers per catch for the seven stations on the northern line of cruising, which extended 140 miles to sea from the general vicinity of San Luis Obispo. Separate records were kept of numbers in naupliar and copepodid (post-naupliar) stages.

A very few individual catches showed no specimens in the fraction counted, but no station showed less than 310, and two exceeded 1,000 per station. In numbers per cubic meter the range would be from about 10,000 to 30,000, a population far from negligible, especially when the constancy of representation is considered, both seasonal and geographical. The largest individual catch from any of the seven stations (134,000 per cubic meter) was made at a depth of thirty meters about seventy-five miles offshore. In most catches the numbers of nauplii were slightly larger than the aggregates of post-nauplii stages.

The tendency to show greatest abundance at or near a depth of thirty meters was very distinct in all cruises, possibly with some relationship to time of day and night, although the time correlation does not appear clear to me. That level was in the lead at four of the seven stations, and it was second at two. Twenty meters and forty meters were somewhat alike. The three levels were within the leading three in fourteen out of twenty-one instances. Contrariwise, the surface and sixty-meter levels were *not* within the leading three at any station.

No clearly marked seasonal differences were observed, although June seemed to be a little the best.

Locality differences were fairly notable, though not so prominent as the differences of levels. The station nearest shore (about nine miles) did not appear most prominent at any depth. On the other hand, the seventy-five-mile station was highly prominent at different depths, no other station showing so well. A few random counts at stations in other lines followed on the cruises indicated that micro-copepoda were regularly represented by considerable populations even at stations nearly two hundred miles from shore, *i.e.*, in waters clearly oceanic in character.

The largest single catch of micro-copepoda was taken with a large catch of diatoms at thirty meters at the seventy-five-mile station. One or two others of the larger catches also gave the impression of a tendency to larger numbers in catches containing notable numbers of diatoms. Superficially, one may be tempted to link such observations with the view commonly expressed by marine biologists that copepods feed heavily on diatoms. Unfortunately for this linkage, the micro-copepoda seem to be too small to feed successfully on the diatoms. For example, in this largest catch most of the diatoms (a large form of *Rhizosolenia styliformis* Btw.) were larger than the nauplii and as long as most of the copepodids.

Even more noticeable than the presence of the micro-copepoda was that of debris or detritus in all catches. In some catches two hundred miles from shore the volume of inert material appeared far greater than the combined volumes of diatoms, dinoflagellates and other micro-plankton. Variable proportions of these inert particles were organic in aspect at different times at different stations, but there was enough constancy of representation of organic material to suggest the idea that the micro-copepoda may depend upon it largely for sustenance; directly by ingestion, indirectly by feeding on bacteria or other organisms associated with the particles. Of course, this does not mean that association with the diatoms does not help the small copepods. It is entirely possible that they need the oxygen liberated by the latter and that the diatoms are benefited by the opportunity to use their wastes.

On account of my commitment to investigations of phytoplankton populations I shall not be able to give any more attention to these fascinating problems of the micro-copepoda. I am offering this memorandum because no quantitative study of marine micro-copepoda at seven specific levels, at all seasons of a single year, in a series of stations extending from littoral into oceanic waters has ever been made before. It is intended merely to give direct evidence of the existence of an important animal population which can be studied to advantage by methods similar to those used for phytoplankton at the Scripps Institution of Oceanography. It is possible that these populations of very small animals constitute an important feature in the supply of foods for young fishes and other prominent marine animals.

W. E. ALLEN

SCRIPPS INSTITUTION OF OCEANOGRAPHY,
UNIVERSITY OF CALIFORNIA

MARSH GAS IN THE ECOLOGY OF SOME PEAT-BOGS

THE peat-bogs or muskegs of the north have been of great interest to plant ecologists and botanists from the highly specialized character of the flora and the peculiarly severe conditions which the plants must endure to survive. There are few habitats which offer more unfavorable conditions in many respects or such a wide range of extremes as these areas, oftentimes very small, afford. Investigations have shown that the pH values of the sphagnum water itself may be as low as 4.5 and that of the carex bog 7 or near this figure, while the open water in places may show a pH of 9. Many other conditions may obtain here which the majority of our mesic plants are unable to

tolerate, including stagnancy and lack of aeration or oxygenation, oftentimes low temperatures due to a permanent frozen substratum a few feet below the bog, lack of sufficient nitrification and low available nitrogen supplies, possibly the presence of organic toxins.

Whatever the synthesis of conditions may be, it is obvious that we have here a habitat and an environmental complex which is highly selective for certain types of flora, among which *Sphagnum, Ericaceae,* carices and other sedges and certain conifers are prominent at one place or another depending upon local conditions, successional stages, etc.

The writer in his youth spent much time observing a small natural bog and pond known as Grassy Pond, Oxford, Massachusetts, the origin of which of course was associated with the last retreat of the Pleistocene ice sheet. A deep basin had been created in the hills, in part here, by a superb esker which had dammed the drainage on the east perhaps 40,000 to 50,000 years ago, if the geological clock is correct. At any rate it was obvious enough that a much larger pond had existed here in the beginning, but it had at last reached the old age stage of its history, represented now mainly by a peat bog with *Sphagnum* in places, quaking bogs, sedges, heaths and with only a small area of free water remaining. There was black, oozy, organic mud everywhere.

It was evident that plant life had been mainly responsible for this profound reclamation. In every respect it is typical of thousands of bogs or muskegs scattered over New England and Canada, but around Grassy Pond there was no trace of living black spruce or of other conifers so characteristic of the more northern coniferous area.

In summer the writer found much interest in traveling barefoot through this bog, to observe the various plants and birds dwelling here, for such plants as *Pogonia ophioglossoides, Calopogon* and *Arethusa* made a colorful flower garden of the area. Traveling here became precarious in places, for the tenacious sedge carpet moved with undulations as one walked along over the soft black ooze, causing the sustaining mat of interlacing roots to sink 8 to 10 inches into the water. In July and August the mat sinking beneath one's footsteps caused a copious rush of big bubbles of gas to the surface. Many times the writer amused himself collecting two quart pailfuls of this gas by holding the pail inverted over the up-rushing bubbles as he walked along, after it had been so manipulated as to become filled with water. When the pail was full of the lighter gas, which was methane or marsh gas, CH_4, he fired it with a match to observe the explosive puff which followed. Great quantities of this marsh gas, it seems, reposed beneath these tough rootlayers of the sedge mat as a zone of bubbles which could not well escape until trampled upon so that they were forced through the organic ooze and interlacing roots. Peculiar conditions prevailed here, for the thin layer of water over the sedge mat was extremely warm due to the absorption of heat from the sun's rays, while to the bare foot the water and ooze below the root zone remained very cool.

It is now relevant to inquire as to what effect if any this marsh gas may have upon the growth of the plants in this peculiar habitat. Is it an additional unfavorable factor with direct more or less toxic effects to which these bog plants must adjust themselves, since it is soluble in water to the extent of 3.3 per cent. by volume at 68° F.? Whether or not it exerts toxic effects, indirectly this gas can not but prove to be an unfavorable factor to some plants, since its presence in abundance in the root zone must greatly dilute the air and the free oxygen supplies leading to conditions of oxygen starvation which many plants of the higher lands seemingly can not tolerate, as is well known.

A striking feature of these methane areas, however, is the abundance of the sedges and the other vegetation naturally colonized here and apparently thriving.

A very extensive literature has developed dealing with the effects of various types of illuminating gas on plants, but as yet no general agreement has been reached as to just what specific components are responsible for the injuries, death or other effects observed. It is well established that these gases in the soil and in the air, under certain conditions may prove very harmful to large trees, shrubs or herbaceous plants.

The coke-oven type of illuminating gas with which some of the work has been done contains a variety of constituents in considerable amounts, including hydrogen as high as 50 per cent., methane 25 per cent., carbon monoxide 8 per cent., nitrogen 10 per cent., naphthalene 3.5 per cent., besides small amounts of carbon dioxide, oxygen, illuminants, etc. A number of these components are unquestionably very harmful to plants in one way or another, and the deleterious effects produced represent a resultant of many factors, making it impossible to decide which unfavorable factors were responsible and to what degree.

Natural gas is extremely rich in methane, running as high as 75 per cent. to 100 per cent., with only very small amounts of some of those constituents which may be present and very injurious in the manufactured coke-oven types.

The gas of the Grassy Pond bog probably closely approaches this type, a nearly pure methane gas, since it was practically odorless, indicating that hydrogen sulfide was not present.

It is well known that the bog methane is due to bacterial decomposition mainly of cellulose vegetable

matter under anaerobic conditions. The gas of the activated sludge process of sewage disposal may also contain 80 per cent. or more of methane.

Recent studies of chemists have aimed to find methods of converting farm wastes such as corn stalks, etc., into a fuel gas, and processes have been proposed which will produce a gas with about 50 per cent. of methane. These results are significant, since methane is exceedingly valuable as a beginning step in the production of hydrogen, ammonia, . . . (NH_3), etc.

Since methane gas, through the increasing use of natural gas and proposed conversion of farm waste, may in the future play a more important part in life, it is well to know all its ecological properties both in nature and in the laboratory.

Methane, it would appear, is a strikingly inactive gas chemically and physiologically, and it is said it can be breathed in concentrations up to 45 to 50 per cent. of the air volume, with no particularly noticeable ill effects aside from a lowering of the oxygen content. It is the active element of the dreaded "fire damp" of coal mines.

The plant life of the Grassy Pond bog would seem to substantiate this inactive physiological behavior, and to the heaths (*Ericaceae*), sedges and other vegetation of these habitats it is perhaps as inert in itself as the free nitrogen which is the necessary diluent component of our atmosphere.

To say the least, marsh gas may be an important environmental factor in some peat bog areas, and under certain conditions may help to create a low oxygen atmosphere in the water and air surrounding the roots of a group of normal associes of these areas, which are highly tolerant of such conditions.

H. A. ALLARD

U. S. DEPARTMENT OF AGRICULTURE

PATENTS FOR CHEMICAL COMPOUNDS

DR. CHARLES E. RUBY has recently criticized[1] the policy of the United States Patent Office and Courts for granting and sustaining patents for new and useful chemical compounds. He affirms that such chemical compounds are not human creations but are entirely acts of nature. In this he is entirely incorrect. Although many chemical compounds are found naturally occurring, the synthetic methods of chemistry enable many very useful pure substances to be produced that are not found in nature. The conception and eventual construction of new and useful chemical compounds are accomplished only and entirely through the application of human mental and physical activity. This most certainly constitutes invention, for invention can not consist of more or less than the adjustment of nature to human use and needs.

[1] SCIENCE, 89: 387, 1939.

New and useful chemical compounds should be and are classified together with new plants and new machines. A new printing press could, in a certain sense, be called an act of nature; for is not its operation and construction down to the minutest detail governed by the laws of nature? What fundamental difference is there between the concept of a new chemical compound and the invention and construction of it by means of chemical reactions and the concept of a new machine and the invention and construction of it by means of mechanical operations? A new chemical compound is no more made available for human use by nature than is an automobile. If a new engine is invented, a patent may be issued on the engine and not upon the use of lathe and drill press in its construction. Similarly, if a new chemical compound is invented (and it is without question at least as much of an invention as the engine in that it requires as much human ingenuity to conceive and produce it) a patent is and should be issued on the compound and not on the reactions used in its production.

If our patent laws are changed so that new and useful chemical compounds are not given the benefit of patent protection, a considerable amount of chemical research will be immediately stopped and society will lose the benefits of both the research and the new compounds. Restricting the patent protection to the method of production of the compound will not give enough protection to warrant the expense of the research, because once the usefulness of a new compound is shown many methods of producing it can be found.

There is only one minor difference between the construction of a new compound and a machine. The one is accomplished through processes and the other operations; but basically they are the same, as the fundamental laws of mechanics and electricity govern both methods of procedure. From a patent point of view, the birth of the idea, the initial construction, the development and the testing of the results follow the same pattern in both cases.

Our great mechanical improvements of the past were greatly stimulated by patent protection. Let us not now retard our present age of chemical development by withdrawing patent protection.

J. H. SIMONS

THE PENNSYLVANIA STATE COLLEGE

THE CONFIGURATION OF GLUTAMIC ACID FROM SCARLET FEVER ANTITOXIN

AFTER reading the remarkable paper by Kögl and Erxleben[1] in which they showed that the glutamic acid, and to a lesser extent some other amino acids of tumor proteins, were partly of the wrong configuration, it

[1] F. Kögl and H. Erxleben, *Zeit. Physiol. Chemie*, 258: 57, 1939.

occurred to the writer that it would be of interest to know whether the glutamic acid of an antitoxin is also partially racemized. If this were the case it would help to explain the great resistance of certain antitoxins toward cleavage by proteolytic enzymes.

Accordingly, a sample of refined and concentrated scarlet fever antitoxin[2] containing three grams of protein was hydrolyzed by hydrochloric acid and the glutamic acid isolated by Foreman's barium salt method. After four recrystallizations the glutamic acid hydrochloride melted at 203° C. and gave the following analysis:

Found:	C, 32.82%; H, 5.48%; N, 7.66%
Calculated for $C_5H_{10}O_4NCl$:	C, 32.69%; H, 5.49%; N, 7.63%

The specific rotation in 9 per cent. hydrochloric acid was $[\alpha]_D^{27°} = +32.2°$ when calculated as the free acid (49.5 mg in 3.06 cc gave a rotation of +0.42° in a one dm. tube). This value is in good agreement with that of d-glutamic acid, +31.5°.

It is therefore apparent that at least the glutamic acid of scarlet fever antitoxin is of the normal configuration. Whether this situation extends to other amino acids and other antitoxins remains to be seen.

ROBERT D. COGHILL

YALE UNIVERSITY

LUCITE

IN my recent paper, "'Lucite' for microscopic Transillumination," published in SCIENCE, Volume 89, No. 2312, April 21, 1939, I made the following statement: "This is presumably the first report of the use of Lucite for this purpose and as a substitute for the Abbe Condenser."

Dr. Elbert C. Cole, of Williams College, has kindly called my attention to the fact that a paper written by him in SCIENCE in April, 1938, entitled "Methyl Methocrylate as a Laboratory Tool," suggested the use of this substance for illuminating living tissue for observation with the microscope. I gladly give Dr. Cole priority as to the use of this substance for illumination.

LEE S. FENT

SCIENTIFIC BOOKS

A HISTORY OF SCIENCE

A History of Science, Technology and Philosophy in the 18th Century. By A. WOLF, professor of the history of science in the University of London. 814 pp., with 345 illustrations. The Macmillan Company, New York, 1939. $8.00.

IT is probably universally true that every reviewer wishes to criticize a book within his own field of interest, and particularly from his own point of view. But, in the case of the volume before us, Wolf's "History of Science, Technology and Philosophy," a reviewer must necessarily take a four-dimensional point of view in order to encompass all that is printed within its 814 pages. The thirty-two chapter headings, beginning with eighteenth century mathematics and ending with philosophy, have called forth all that is implied in pure science and technology, including agriculture, scientific instruments, building, transportation, metallurgy, telegraphy, psychology, medicine, economics, social science, geography and philosophy. This wide range of subject-matter is new from the standpoint of the purely academic treatment of the history of science; it should require, therefore, a group of reviewers or encyclopedists to evaluate properly the true merit of this book.

This volume is the second of a series planned by Professor Wolf, and is of the same general character and scholarship as the first book, which was critically reviewed in SCIENCE.[1] The main points of criticism which Dr. Sigerist brought out in this review concerning the treatment of the history of science in the sixteenth and seventeenth centuries are still valid in the volume for the eighteenth century. There is the same lack of coordination and continuity of subject-matter, and there is no critical analysis of the theory, work and philosophy of each scholar, inventor and philosopher. According to Professor Wolf's treatment in the historical method, each field of activity has gone its own appointed way without apparent reference to the basic sciences.

Modern science has its heritage, and a rich one, from the past. Each succeeding age or century shows something of a mathematical progression in its accomplishments. Accordingly the sixteenth and seventeenth centuries were treated in one volume, while the eighteenth century alone required one volume with one hundred pages more for its treatment. The eighteenth century was a critical one in that scientific discoveries, based upon fundamental principles and natural laws, were asserting themselves in the form of practical application to the needs of society and the betterment of man. Professor Wolf has shown that advances were made in almost every field of intellectual enterprise and that there was an unprecedented spread of knowledge beyond the circle of the specialists. He has by comparison shown that the age of enlightenment was a worthy heir to the age of genius. But he has treated upon this only in the form of chapters on independent subjects, and not as a continuous history

[2] Kindly furnished by Parke, Davis and Company.

[1] SCIENCE, 83: 2150, 262–264, March 13, 1936.

of ideas, movements or results. The task of bringing order into the apparent tangle of luxuriant growth of scientific and technological advances is almost an impossible one, but Professor Wolf has succeeded to a large degree in setting forth what is known. There is nothing particularly new in what the author has written; he has gathered his material from a rich source of original work of the great pioneers in each field.

The cultural aspect of science upon society should have been continually emphasized. One of the best examples of the influence of an institution upon an epoch was that of the Royal Society of London upon the life and thought of the colonial period of American history and culture. We find a good account of the experiments of Franklin with electricity in 1746 and succeeding years. These were the great pioneer days of research in static electricity, and Wolf has treated carefully of Franklin's influence on the principal workers in this field. However, as well as commenting upon Franklin fully and deservedly, the author should have included a better treatment of the work of other Colonial scholars such as Cotton Mather, Paul Dudley, James Logan and John Bartram, who did pioneer experimentation on plant breeding, and Zabdiel Boylston, who was famous for being the first in the Colonies to inoculate for smallpox. The Royal Society recognized these men and approximately fifteen other colonial scholars during the eighteenth century of colonial America, by electing them as fellows.

A true history of science can be written by covering one field by epochs, but not by encompassing the whole range of human thought and invention. The history of art, science or philosophy should be treated in the form of a great symphony in which interrelations are shown in movements, where each great crescendo seems to be the result of a gradual upbuilding of ideas, feelings and moods, all influencing the human soul in its constant struggle for greater self-expression and life. A historian can be a Beethoven, a Mozart or a Wagner.

However, as stated in the beginning, the reviewer takes the liberty of judging this book from an unusual point of view, that of a librarian or bibliographer. The constant demand upon this profession for appraisal of the worth of a book and its service to readers encourages the bibliographer or reference librarian to become specialized in some field of research. The librarian of to-day, in this country, is becoming more and more conscious of scholarship. He is aware of his superior modern library technique and is now seeking the cultural aspects of his profession. Standard reference or source books are the essential tools of the reference librarian, and to this class Professor Wolf's book belongs in large measure. What has been set forth in each chapter and sub-chapter is clearly and concisely stated, sufficiently so that if further details are required the reader is referred to the original source. Also, for the bibliographer who wishes to prepare a select or critical bibliography of original source references and biographies of the great scientists of the past, the material is readily available. Professor Wolf has used good judgment in his selection.

The index, in its treatment by author and subject, leaves much to be desired. In cases of more than three references to a scholar it should have been more descriptive or analytical. The table of contents does not aid us here, in spite of the fact that it is well prepared from another point of view. This is a disconcerting phase for the reference librarian. In seeking to ascertain the work of any scholar, as for example, Newton, Euler, D'Alembert, etc., one does not find complete reference to his accomplishments. For example, in the chapter on light, which is comprehensive for general reference, mention is made of Euler and his work on light, leaving us not quite certain that this was all he did. The index does not show his profound discoveries in mathematics and physics, but gives only a large number of blank page references which makes it difficult to find record of his work in other fields.

The format is good, the book being well printed on durable light paper, which was necessary in order to handle a volume of 814 pages conveniently. The illustrations and line drawings are carefully selected and printed, and the numerous portraits lend dignity and beauty to the volume, since they were printed on paper especially adapted for such work. Professor Wolf has placed before the librarian and general scholar a decidedly useful compendium of scientific, technical and philosophical knowledge of the eighteenth century, which should be on every reference shelf, private or public.

FREDERICK E. BRASCH
LIBRARY OF CONGRESS

BIRDS AND THE SPECIES PROBLEM

A Systematic Review of the genus Phylloscopus (Willow-Warblers or Leaf-Warblers). By CLAUD B. TICEHURST. British Museum (Natural History), 1935. Pp. 193. Two colored plates.

At first sight it might well appear that a revision of a genus of Old World Warblers (*Sylviidae*) would be of little interest to American naturalists, but I should like to recommend Dr. Ticehurst's book for supplementary reading in all biological laboratories. The method of presentation is so interesting and so adequate, that we seem to have revealed to us the very course of events by which new races and species arise. The work is based on the examination of about nine thousand specimens, and much field work. Under each species we have details concerning the breeding range,

and also the winter range, reached by migratory movements. The characters cited are divided into two groups, those which may be studied in the museum, and those which may be observed in the field. The latter include peculiarities of voice or song, which are often strongly characteristic of birds which would be hard to distinguish in life by vision alone. There are recognized thirty species, but these are increased to sixty-seven if we count all the subspecies. What is a subspecies? It is a recognizably distinct population which in some part of its range intergrades with one or more allied populations, all together constituting the species. Such subspecies, regarded objectively, may in certain cases owe their characters to the direct effects of a special environment. These have no proper genetic basis, and are not equivalent to true subspecies as recognized in taxonomy. But it is clearly brought out by modern research that genuine subspecies may have two different sorts of origin; they may arise by gradual differentiation from a parent stock, or they may be due to the crossing of two distinct types, which would otherwise be regarded as good species. In the one case, the subspecies represents a stage in the origin of species; in the other, it represents the breaking down of specific characters which have developed in isolation. Thus, for instance, Ernst Mayr in a paper just published, on the Birds of New Guinea, points out that *Megapodius affinis* and *eremita* are very distinct, but on Dampier Island they meet and freely cross, no physiological barrier having arisen to prevent it. Hence they must be treated as a single species. Ticehurst, in his treatment of subspecies of warblers, shows that a very curious condition may arise. He finds that two subspecies may develop from a common species, and spreading outward become increasingly distinct. At length, they may happen to invade each other's territory, and when so doing, may behave as perfectly distinct species, keeping distinct from one another. This happens in the case of the forms of *Phylloscopus trochiloides,* as is explained in detail, with a map. A very interesting case is that of *Phylloscopus borealis kennicotti* (Baird, 1869), the only member of the genus which reaches North America. It has evidently come over from Asia, and while it breeds in Alaska, it still migrates southward in the winter along the coast of Asia, and not at all along our Pacific Coast. The migration route is thus older and more persistent than the subspecies.

Another noteworthy fact is that whereas a species may go far south in migration, and thus have an immense range, it may nevertheless throw off satellites, if one may so call them, which become permanent residents somewhere along the path of migration. Thus *Phylloscopus collybita canariensis* is a permanent resident in the western group of the Canary Islands, while *P. c. exul* occurs only on Lanzarote, in the same archipelago. These cases recall some on the islands off the west coast of North America. *Regulus calendula obscurus* (also one of the Sylviidae) occupies Guadalupe Island; while the humming-bird, *Selasphorus alleni sedentarius,* instead of migrating to Mexico, is a permanent resident on Santa Catalina, San Clemente and Santa Cruz Islands.

T. D. A. COCKERELL

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SOCIETIES AND MEETINGS

THE VIRGINIA ACADEMY OF SCIENCE

THE Virginia Academy of Science held its seventeenth annual meeting in Danville on May 4, 5 and 6 with weather conditions favorable for its two field trips, one in biology and one in geology. There was much interest in a new section on engineering, which presented a program of 16 papers.

The finance committee brought in an encouraging report, and so two new lines of work were undertaken by authorizing the incoming president to appoint (1) a committee to encourage the formation and foster the development of science clubs in the high schools of the state, (2) a committee to establish an official academy publication which will probably be known as the *Virginia Journal of Science.* The academy also referred to its conservation committee for especial consideration the problem of the conservation and preservation of the Dismal Swamp.

The academy prize of $50.00 was awarded to M. J. Murray and Forrest F. Cleveland, of Lynchburg College, for a paper entitled, "The Use of Polaroid in Depolarization Measurements on Raman Lines," and the Jefferson Gold Medal was awarded to G. M. Shear and H. D. Ussery, of the Virginia Polytechnic Institute, for a paper entitled, "Frenching of Tobacco Distinguished from Thallium Toxicity by Spectrographic Analysis."

In the sectional meetings Astronomy, Mathematics and Physics presented 20 papers; Biology 13; Botany 7; Zoology 10; Chemistry 26; Education 12; Engineering 16; Geology 18; Medicine 9; and Psychology 7, making a total of 138 besides a symposium on "Organic Analytical Reagents" and a round table on "The Problems of Applied Psychology."

The following officers were elected: Ruskin S. Freer, of Lynchburg College, *President;* Wortley F. Rudd, of the Medical College of Virginia, *President-elect;* E. C. L. Miller, of the Medical College of Virginia, *Secre-*

tary-Treasurer; and I. A. Updike, of Randolph-Macon College, *Assistant Secretary.* New members of the council are: C. E. Myers, of the State Board of Education; Preston Edwards, of Sweet Briar College; and Marcellus H. Stow, of Washington and Lee University.

The new officers of sections are as follows:

Astronomy, Mathematics and Physics: Chairman, Alexander Vyssotsky, of the University of Virginia; *Secretary,* F. B. Haynes, of the Virginia Polytechnic Institute.

Biology: Chairman, Bruce D. Reynolds, of the University of Virginia; *Sub-Chairman,* J. G. Harrar, of the Virginia Polytechnic Institute; *Secretary,* Lena B. Henderson, of Randolph-Macon Woman's College.

Chemistry: Chairman, W. J. Frierson, of Hampden-Sydney College; *Secretary,* William G. Guy, of the College of William and Mary.

Education: Chairman, John Alex Rorer, of the University of Virginia; *Secretary,* Paul G. Hook, of Clifton Forge.

Engineering: Chairman, Albert H. Cooper, of the Virginia Polytechnic Institute; *Secretary,* D. H. Pletta, of the Virginia Polytechnic Institute.

Geology: Chairman, E. R. Casto, of Emory and Henry College; *Vice-Chairman,* E. C. H. Lammers, Washington and Lee University; *Secretary,* William M. McGill, of the Virginia Geological Survey.

Medicine: Chairman, Carl C. Speidel, of the University of Virginia; *Secretary,* Guy W. Horsley, of Richmond.

Psychology: Chairman, Richard H. Henneman, of the College of Willian and Mary; *Secretary,* William M. Hinton, of Washington and Lee University.

The meeting next year will be at the Randolph-Macon Woman's College, Lynchburg, Virginia, and in 1941 at the Medical College of Virginia, Richmond, Virginia.

E. C. L. MILLER,
Secretary

THE KENTUCKY ACADEMY OF SCIENCE

THE twenty-sixth annual meeting of the Kentucky Academy of Science was held at Murray State Teachers College, Murray, Ky., on April 28 and 29. The principal address, on "Science and Human Mores," was given by the president, Dr. W. R. Allen.

Fifty-four papers were presented in six divisional meetings. Two divisions, the Kentucky Association of Physics Teachers and the Louisville Astronomical Society, met in joint session. A feature attraction at one of the two meetings of the Division of Biological Sciences was the color film showing "Animal Life in the Kentucky Mountains," made and given by W. A. Welter, of Morehead, Ky.

An annual cash award of $50.00 for five successive years has been placed at the disposal of the academy by Mr. and Mrs. Fain W. King, Wickliffe, Ky. This award is to go to the individual presenting the best and most original paper at the annual meeting. The recipient of the award for 1939 remains to be determined.

On Saturday, April 29, after a final general session at Murray, the academy was the guest of Mr. and Mrs. Fain King, at the "Ancient Buried City" at Wickliffe. This is an excavation of Moundbuilder ruins and burials on a bluff overlooking the Mississippi.

Newly elected officers for 1939–1940 are: *President,* A. W. Homberger, University of Louisville; *Vice-President,* Chas. Hire, Murray State Teachers College. Reelected were: *Secretary,* Alfred Brauer, University of Kentucky; *Treasurer,* Wm. J. Moore, Eastern Teachers College; *Representative* of American Association for the Advancement of Science on Council, A. R. Middleton, Louisville. *Councilor to Junior Academy,* Anna A. Schnieb, Richmond.

ALFRED BRAUER,
Secretary

SPECIAL ARTICLES

THE EFFECT OF CERTAIN CHEMICALS ON THE HATCHING OF MOSQUITO EGGS

IN a study of the factors affecting the hatching of mosquito eggs it was found that only 2 per cent. of the eggs of *Aedes vexans* Meig. and *Aedes aldrichi* Dyar and Knab would hatch when flooded with unmodified tap water or with water from the Columbia River. Since eggs of these species deposited on the soil among fallen leaves and grass of cottonwood and willow flats bordering the Columbia River hatch readily when these areas are flooded, it was thought that certain chemicals dissolved from vegetation might provide the necessary stimulus.

Experiments conducted to verify this idea showed that tap-water infusions of dry cottonwood leaves, willow leaves and grass gave consistently larger hatches than either tap or river water alone. Fallen leaves 3 to 6 months old which had dried at room temperature were used in making the infusions. The leaves were strained out with a coarse cloth before the liquid was applied to the eggs. Infusions made with green leaves also caused hatching. Eggs gathered in August and flooded with 2-hour infusions representing 2 or 3 milligrams of leaves per cubic centimeter produced the largest hatches. The egg-hatching stimulant was present in these infusions in small quantities within 10 minutes after the leaves were flooded at room temperature and reached its most effective strength in from 1 to 2 hours.

More extensive tests were made with eggs gathered

in January and flooded after they had been kept at room temperature for 10 days to bring them out of their winter dormant condition. These eggs gave maximum hatches with infusions made from 10 milligrams of dry willow leaves per cubic centimeter of water. With infusions of this strength 80 per cent. of the eggs of both species hatched. The percentages of hatch for the two species showed close correlation at all strengths tested.

Preliminary tests with the eggs of *Aedes dorsalis* Meig. showed that these eggs also require the hatching stimulant supplied by leaves and grass. In tests with *Theobaldia incidens* Thomson, *Culex pipiens* L. and *Anopheles punctipennis* Say the eggs of all three species hatched readily in unmodified tap water. The eggs of *Theobaldia, Culex* and *Anopheles* are laid directly on the water, whereas those of the three species of *Aedes* tested are laid on the soil and hatch when flooded by rising rivers, high tides, etc.

In an effort to determine the nature of the egg-hatching stimulant, a number of organic chemicals and inorganic chemical elements necessary for plant and animal growth were tested individually and in combination. These did not cause hatching. However, it was shown that the stimulant was present in oats, milk and beef liver.

Pantothenic acid,[1] a recently discovered growth stimulant which is believed to be present in all living cells, occurs abundantly in liver, milk and yeast. The addition of infinitesimal amounts of the acid produces a remarkably stimulating effect on the growth of various types of plants and single-celled animals. The effects of this acid were therefore tested on the eggs in a medium composed of several chemicals in which the acid was produced by yeast. It was found that asparagine, one of the ingredients of the medium, caused the eggs to hatch and that potassium phosphate, another ingredient, acted to increase this hatch. As pantothenic acid was not available except in solution with these two chemicals, its effect could not be definitely determined, but it appeared to have no stimulating action. Solutions containing about 1 milligram of asparagine and 0.5 milligram of potassium phosphate per cubic centimeter of tap water produced the largest hatches, 77 per cent. of the eggs of *Aedes vexans* and 42 per cent. of those of *Aedes aldrichi* eggs.

Six amino acids were found which were stimulating to the eggs. These are asparagine, glycocoll, alanine, cystine, leucine and aspartic acid. The first two were most effective. Hatches were increased with both these materials when calcium or sodium phosphate was added. Putrecine, urea and potassium acetate also caused hatching.

It seems probable that the amino acids and proteins present in vegetation may be the stimulants which cause the eggs to hatch when flooded in nature. Further research work on the composition and action of the egg-hatching stimulant, the species affected by it and its relation to mosquito egg hatching in nature are under way.

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PLANT QUARANTINE,
U. S. DEPARTMENT OF AGRICULTURE

[1] These tests were made possible through the cooperation of Dr. Roger Williams, of the Chemistry Department of Oregon State College, who kindly supplied the acid and assisted with the tests.

AN OBSERVATION SUGGESTING THE PRESENCE OF A GONADOTROPIC HORMONE IN ROYAL JELLY[1]

THIS preliminary note presents evidence suggesting that extracts of royal jelly injected subcutaneously into immature female rats produce precocious development of the ovaries.

Royal jelly is an essential factor in the life of a colony of bees. It is secreted by glands in the mouth of the worker bee. It is fed to the queen while she is laying eggs and to all new-born larvae for the first three days of their lives; from then on only those larvae destined to become queens receive this special diet; queen larvae receive this food during their whole larval stage. All other female larvae, that is, those destined to become workers, are fed on nectar and pollen, after the first three days. These two types of females are strikingly different. The worker takes twenty-one days to develop from egg to adult, the queen sixteen; yet the queen bee is nearly twice as large as the worker. The worker can lay eggs only under extraordinary circumstances; the queen lays eggs steadily for as long as three or four years. The ovaries of the worker are infantile, while those of the queen are large. The worker exhibits many maternal instincts, the queen none. The fact that all these differences apparently could be produced simply by the giving or withholding of royal jelly led to the deduction that royal jelly might contain an active principle that would behave like a gonadotropic or growth hormone.

Hill and Burdett,[2] working on rats kept on a "vitamin E free diet," reported correction of this deficiency by the feeding of royal jelly. Mason and Melampy[3] later repeated this work and were unable to verify it

[1] From the Departments of Pediatrics and Surgery, Harvard Medical School, and The Children's Hospital, Boston.

[2] L. Hill and F. F. Burdett, *Nature*, 130: 540, 1932.

[3] H. K. Mason and R. M. Melampy, *Proc. Soc. Exp. Biol. and Med.*, 35: 459, 1936.

when an actual vitamin E deficiency was established. Investigation of hormones in insects has only recently been undertaken. In this regard the contributions of Wigglesworth[4] and Weed[5] on the corpora allata and its relation to ovulation in insects are intensely interesting.

For the work reported in this communication, two extracts of royal jelly[6] were prepared with dilute NaOH and one with aqueous pyridine (Fevold[7]). Twenty immature female rats, twenty-one days old, were used. These had been raised and weaned under our observation and were all fed the same standard diet during the experimental period.

Ten rats of this experimental group were kept as controls. The remaining ten were injected with extracts of royal jelly. Amounts varying from 60 to 700 mgm of natural royal jelly equivalent were injected subcutaneously on each of five days; the average amount of extract in each injection was 0.3 cc. On the twenty-sixth day of life, the ovaries were removed from all twenty animals. The ovaries of the control group, as would be expected, showed primary follicles that were small and relatively inactive. The ovaries of the animals that had received royal jelly were moderately enlarged, with the Graafian follicles in varying stages of rapid maturation. There was little evidence of luteinization. The twenty control ovaries (two from each animal) averaged 9 mgm in weight; the twenty stimulated ovaries averaged 15 mgm. However, even the smallest of the stimulated glands showed unusual follicular activity. The vagina did not open in any of the controls or treated animals. The degree of the response was directly proportional to the strength and amount of the extract used. The pyridine extract was the most potent of those tried. All gained weight steadily, with the treated animals tending to be slightly heavier than the controls at the end of the experiment.

It is obviously too early in this investigation to draw final conclusions. It seems particularly interesting, however, that this material produced by an insect apparently contains a principle which behaves like a hormone when injected into an animal. The results presented in this communication prompt speculation as to the possibility of an anlage of Rathke's pouch, present in the bee and acting as the functional evolutionary fore-bear of the pituitary gland.

[4] V. B. Wigglesworth, *Quart. Jour. Micr. Sc.*, 79: 91, 1936.

[5] I. G. Weed, *Proc. Soc. Exp. Biol. and Med.*, 34: 883, 1936.

[6] The author is grateful for the cooperation of Dr. R. M. Melampy, the A. I. Root Company of Medina, Ohio, Mr. Allan Latham, of Norwichtown, Conn., Mr. C. C. Ellison, of Belton, S. C., and Dr. Ouida Abbott, of Gainesville, Fla., who supplied the royal jelly used in these experiments.

[7] H. L. Fevold, F. L. Hisaw and S. L. Leonard, *Am. Jour. Physiol.*, 97: 291, 1931.

Summary: The injection of extracts of royal jelly into immature female rats for five days is attended by precocious development of the Graafian follicles.

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RECOVERY OF THE VIRUS OF EQUINE ENCEPHALOMYELITIS (WESTERN TYPE) FROM HUMAN BLOOD SERUM

ON August 7, 1938, through the courtesy of Dr. Ellis Sox blood was received from a man at the Tulare County Hospital in the San Joaquin Valley, California. He had been admitted to the hospital on August 2 in a state of coma with a rectal temperature of 108° F. His earlier symptoms were those of severe headache, stiff neck and general malaise. The blood was taken on August 6, or not long before death from what was considered an acute encephalitis.

At the time this blood was received, the virus of equine encephalomyelitis had not as yet been recovered from a human case and had not been considered a possibility as the etiological agent of the encephalitic cases occasionally occurring in this region. However, neutralizing antibodies for the St. Louis encephalitic virus[1] had been found in many serums of the recovered patients so that this S serum was tested for antiviral properties. It was negative and the serum was stored in the refrigerator for future reference. After the later recovery of the equine virus from a human case,[2] this serum was remembered and on October 8, two months after collection, it was inoculated intracerebrally into two mice. Two weeks later one mouse became paralyzed in the hind legs. Both animals were killed, and a 10 per cent. suspension of their brains in Ringer's solution was passed on to other young Swiss mice.

After several serial passages a virus was established that killed mice in 4 days. Berkefeld filtrates of the brain material were also infective for mice. The virus was found to be infectious for monkeys, guinea pigs and rabbits with a four- to five-day incubation period, and typical symptoms for the virus of equine encephalomyelitis of the western type.

From the clinical picture in guinea pigs, a weak prostration, usually with a dragging of the hind legs, and a typical temperature curve rising to a maximum on the third day, the virus seemed to more closely resemble the original equine western type than did the other recently recovered human or Br strain previously described.[2] The latter was more virulent, being infective in a 1–10,000,000 dilution in mice, had a 60-hour duration accompanied by more spasticity

[1] B. F. Howitt, *Proc. Soc. Exp. Biol. and Med.*, 38: 334, 1938.

[2] *Ibid.*, SCIENCE, 88: 455, 1938.

when large doses were given and showed a more abrupt temperature curve in guinea pigs. The new S strain was infective to mice intracerebrally in a dilution of 1–100,000 and occasionally 1 to 1,000,000 and was also fatal by intranasal, subcutaneous and intracutaneous routes of injection.

Wild mice, *Peromyscus maniculatus,* could be infected intracerebrally with 0.03 cc of a 1–100,000 dilution of the virus. Young puppies also succumbed after injection by the same route. The virus could easily be grown on the chorioallantoic membranes of the developing chick, and is now in the 40th passage. The embryo dies in about 15 to 18 hours and the virus may be recovered from the membranes, the amniotic fluid and the tissues of the chick. The Br strain could likewise be grown in the developing egg.

Immune serums of the S strain gave positive neutralization and complement fixation tests against the Br and the western equine types of virus, but occasionally there was a slight crossing with the eastern variety by the first method. Eastern immune serums, however, failed to neutralize the S virus, as did also the immune serums of the Moscow 2 equine type and the Japanese B virus. Both tests were negative against the St. Louis encephalitic strain. There was no crossing with the eastern variety in the complement fixation test, although occasionally the S antigens were weak when used against the Br and the western equine serums. The S serums usually were positive against the other two western antigens. It was also found feasible to use as antigen the supernatant fluid after centrifugation of the ground membranes of eggs infected with either of the two strains.

In cross tissue immunity experiments, 3 out of 4 guinea pigs immune to the S strain succumbed after intracerebral injection of the eastern type, while the fourth became sick and weak but recovered. One old guinea pig immune to the latter virus, after inoculation with the S strain, ran a temperature and became ill but recovered.

From the general characteristics of this S strain, the incubation period, temperature curve, clinical picture in animals and from the serological and immunological reactions, it is apparent that the western variety of equine encephalomyelitic virus may be recovered from adult human blood serum even after prolonged storage in the refrigerator.

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ENCEPHALOMYELITIS IN MONKEYS

DURING the last few years equine encephalomyelitis has been spreading widely among the horses of the United States. Though the possibility of its infectiousness for man had been realized,[1] it was first recognized[2] last year as the cause of serious disease in man. Innumerable people are exposed during an epidemic in horses; and now many laboratory workers have intimate contact with the disease and its causative viruses while making the embryo vaccine[3] being used to control the disease. We have been carrying out experiments with monkeys to throw light on probable modes of human infection and to indicate what might be done to control or check the disease in man. These experiments have been designed to determine (1) the sensitivity of monkeys to infection by different routes; (2) the influence of hyperimmune serum on the course of the disease; and (3) the possibility of protecting by vaccination.

It has been known[4] that monkeys are susceptible to encephalomyelitis virus injected into the brain and that they can in some instances be infected by virus introduced into the peripheral circulation. We have found that when a massive dose of either eastern or western virus is instilled intranasally into a young rhesus monkey, it will in most instances succumb to a fatal infection. The first symptom of this infection has been fever. The animal has been mildly excitable during this febrile stage, after which it has become paralyzed, has sunk into coma and has died. The symptoms of the two American diseases have been similar, except that as in other animals, the eastern has run a shorter course. We have never observed the recovery of any young monkey infected with either strain if it became paralyzed. A few of the animals receiving intranasal virus have remained healthy; we have found that at least some of these monkeys developed a high content of neutralizing antibodies after exposure. They have therefore suffered non-clinical infections. In our experiments disease has not been produced by very large doses of virus injected subcutaneously or intravenously, though these inoculations have been followed by the appearance of circulating antibodies. Dropping virus into the eye has not resulted in either disease or measurable antibodies. Eastern virus injected intralingually and western virus introduced by stomach tube have proved fatal, but we have not diseased healthy animals by keeping them caged with sick ones.

Hyperimmune horse serum has provided passive protection against nasally instilled virus. Incomplete protection has been furnished by serum administered within three hours of infection. In numerous trials we have never seen any beneficial effect from such a serum given at and after the time of first temperature

[1] K. F. Meyer, *Ann. Int. Med.*, 6: 645, 1932.
[2] L. D. Fothergill, J. H. Dingle, S. Farber and M. L. Connerly, New England Jour. Med., 219: 411, 1938; L. T. Webster and F. H. Wright, SCIENCE, 88: 305, 1938; B. F. Howitt, SCIENCE, 88: 455, 1938.
[3] J. W. Beard, H. Finkelstein, W. C. Sealy and R. W. G. Wyckoff, SCIENCE, 87: 89, 490, 1938.
[4] E. W. Hurst, *Jour. Path. Bact.*, 42: 271, 1936.

rise, even when this serum was equivalent in amount to the injection of 500 cc into a 150-pound man.

Animals twice vaccinated with crude chick embryo vaccine have in all but one instance been completely protected against massive doses of intranasal virus. This vaccination has produced antibodies which were present in high titre after eastern, in lower titre after western vaccine injection. Such titres were not appreciably enhanced by the subsequent test dose of virus. Clarified and deformalinized embryo vaccines have now been made which have been effective in guinea pigs and which should be more suitable for any human use that may in the future be needed.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

A HIGH RESOLVING POWER ULTRACENTRIFUGE

IN the case of most large molecular weight substances the molecular weights and sizes are determined by measuring the rates with which they settle out in an ultracentrifuge, together with their diffusion constants.[1] Usually the material is enclosed in a sector-shaped cell with transparent windows so that the rate of sedimentation can be observed optically. Since the diffusion constants are very small for large molecular weight substances, the sedimentation boundaries remain comparatively sharp for long periods of time provided the substance is homogeneous. If the substance contains two or more molecular species, each forms a separate sedimenting boundary. The ability of an ultracentrifuge to separate a mixture of molecular species is proportional to $\omega^2 r h$, where ω is the angular velocity of the centrifuge, r the distance from the axis of rotation and h the length of the column of solution which may be observed.[1] In the modern ultracentrifuges the strength of the rotor materials sets an upper limit to ω, r and the height of the cell, h, that can be used.[1,2] The purpose of this note is to describe briefly a method which, in effect, increases the length of the column of solution under observation without increasing the length of the cell. The method consists in forcing the solution through the transparent cell along the radius in the opposite direction to the motion of the sedimentation boundary. Consequently, if the rate of flow of the solution is equal to the rate of sedimentation, the sedimentation boundary remains stationary in the cell for long periods of time. This not only allows the sedimentation constants to be measured with precision but also makes it possible to determine the sedimentation constants for two or more molecular species in a mixture with very small differences in molecular weight.

Fig. 1 shows a cross-section of the ultracentrifuge rotor which was used to make a preliminary test of the method. This rotor was spun inside an evacuated chamber by an air-supported air-driven turbine (not shown but described previously[2,3]) situated above the

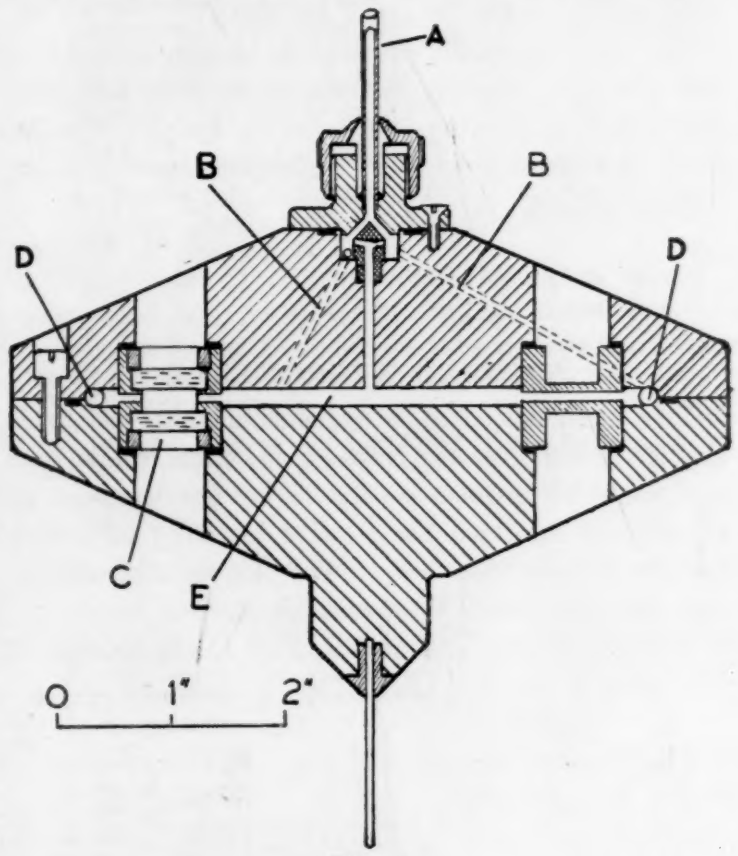

FIG. 1

vacuum chamber. The shaft A is a stainless steel tube which connects with the tubes B. B connects with a ring-shaped tube D, which in turn communicates with the periphery of the cell C. The cell C is sector-shaped with crystal quartz windows for viewing the sedimentation; it is 12 mm long and its center is 45 mm from the axis of rotation. Short channels connect the ends of the cell C and the cylindrical collecting chamber E. To operate the apparatus the rotor is accelerated to the desired speed, and the material to be centrifuged is injected into A with a hypodermic syringe. The material flows through B, D, and into the cell C. In this way the cell is filled about two thirds. Then as the sedimenting boundaries move outward toward the periphery, more material is injected into A at the proper rate to maintain the boundaries near the center of the cell. The solvent is collected in the chamber E. In most of these preliminary tests hemoglobin (kindly furnished by Professor A. Chanu-

[1] Svedberg, *Ind. Eng. Chem., Analytical Ed.*, 10: 113, 1938; *Proc. Roy. Soc.*, A 170: 40, 1939.

[2] Beams, *Rev. Mod. Phys.*, 10: 245, 1938.

[3] Beams, Linke and Sommer, *Rev. Sci. Inst.*, 9: 248, 1938.

tin) was used. It was found that the sedimentation could be observed for practically as long as desired, the limiting factor apparently being only a blurring by diffusion (a dilution due to the field gradient also was noticeable). The sedimentation of colloidal particles very much larger than the hemoglobin molecules also was observed until E was filled. The preliminary tests indicate, in accord with theory, that the resolving power of the ultracentrifuge can be much increased, at least in some cases. A new and stronger rotor with the cell further from the axis is under construction with which further tests will be made.

The writer is greatly indebted to Messrs. Fritz Linke and Philipp Sommer, instrument makers, who constructed the apparatus, and to the Rockefeller Foundation for a grant in support of the development of the ultracentrifuge.

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A SMALL HYGROMETER

THE construction of a hygrometer that was much smaller and more sensitive than the usual commercial equipment became a necessity during the course of an experiment in which the relative humidity of a long narrow sealed tube had to be determined without changing its humidity by opening it.

This instrument is shown in Fig. 1. It consists of the balance wheel, hair spring and small portions of the bearing plates of a small jeweled wrist watch attached to a glass plate. To the escape nub on the arm of the balance wheel is attached a very fine human hair carefuly washed in ether and alcohol. It then bends over the shaft of the balance wheel and is attached at the opposite end of the glass plate under slight tension produced by the hair spring. A very fine glass rod attached to the circumference of the balance wheel indicates the motion produced by the elongation or contraction of the hair with humidity changes. A more sensitive measurement may be obtained by attaching small mirrors to the rim of the balance wheel and the regulator arm and using the distance between the spots of light reflected as an indicator of the motion produced by humidity changes.

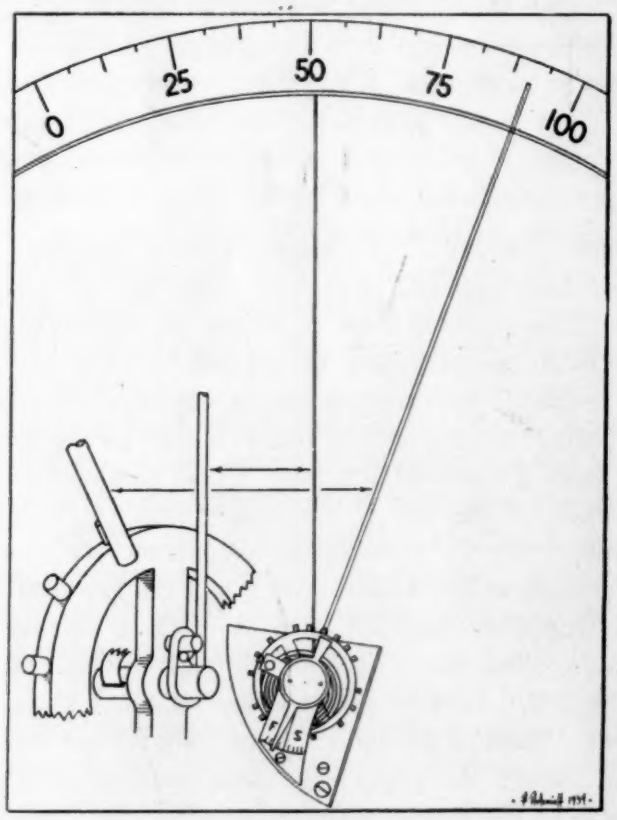

FIG. 1

The instrument was calibrated and checked by alternately placing it in a closed chamber first over water and then over concentrated H_2SO_4. All readings were within 2 per cent. R. H. When placed above salt solutions in closed containers, the instrument checked to about 1 per cent. in every instance. Under these conditions equilibrium was reached within 15 minutes.

The advantages of this instrument are threefold. (1) It is quite accurate and may be easily read without altering the humidity in the chamber. (2) As the small size makes its use in very small spaces possible without changing the humidity, humidity of microclimates may be obtained. (3) It is inexpensive and easy to construct.

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RODERICK CRAIG

UNIVERSITY OF CALIFORNIA, BERKELEY

BOOKS RECEIVED

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